



BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI - 620 024

B.Sc., Zoology

CHOICE BASED CREDIT SYSTEM – LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2026 - 2027 onwards)

SEM	PART	COURSES	TITLE	INS. HRS.	CREDITS	EXAM. HOURS	MAXIMUM MARKS		
							INT.	EXT.	TOTAL
I	I	Ability Enhancement Course – I (AEC - I)	(Tamil \$ / Other Languages +, #)	6	3	3	30	70	100
	II	Ability Enhancement Course – II (AEC - II)	English Course - I	6	3	3	30	70	100
	III	Core Course - 1 (CC - 1)	Invertebrata	4	4	3	30	70	100
		Core Practical - 1 (CP - 1)	Laboratory in Invertebrata	4	4	3	40	60	100
		Allied Course – 1 (AC - 1)	Botany - I	4	4	3	30	70	100
		Allied Practical - 1 (ACP-1)	Laboratory in Botany-I	2	**	**	**	**	**
	IV	Value Education		2	2	3	30	70	100
		Interdisciplinary Course – 1 (IDC - 1) #	One Course from Outside Department	2	2	3	30	70	100
	Total			30	22	--	--	--	700
II	I	Ability Enhancement Course – III (AEC - III)	(Tamil \$ / Other Languages +, #)	6	3	3	30	70	100
	II	Ability Enhancement Course – IV (AEC - IV)	English Course - II	6	3	3	30	70	100
	III	Core Course - 2 (CC - 2)	Chordata	4	4	3	30	70	100
		Core Practical - 2 (CP - 2)	Laboratory in Chordata	4	4	3	40	60	100
		Allied Course – 2 (AC - 2)	Botany - II	4	4	3	30	70	100
		Allied Course Practical - 1 (ACP-1)	Laboratory in Botany-I	2	4	3	40	60	100
	IV	Skill Enhancement Course - 1 (SEC - 1) ##	Naan Mudhalvan Course	2	2	3	30	70	100
		Interdisciplinary Course – 2 (IDC - 2) #	One Course from Outside Department	2	2	3	30	70	100
	Total			30	26	--	--	--	800

III	I	Ability Enhancement Course – V(AEC - V)	(Tamil \$ / Other Languages +, #)	6	3	3	30	70	100
	II	Ability Enhancement Course – VI (AEC - VI)	English Course - III	6	3	3	30	70	100
	III	Core Course - 3 (CC - 3)	Cell and Molecular Biology	4	4	3	30	70	100
		Core Practical - 3 (CP - 3)	Laboratory in Cell and Molecular Biology	4	4	3	40	60	100
		Allied Course – 3 (AC - 3)	Chemistry - I	4	4	3	30	70	100
		Allied Course Practical - 2 (ACP-2)	Laboratory in Chemistry	2	**	**	**	**	**
	IV	Skill Enhancement Course - 2 (SEC - 2) ##	Naan Mudhalvan Course	2	2	3	30	70	100
		Interdisciplinary Course – 3 (IDC - 3) \$\$	One Course from Outside Department	2	2	3	30	70	100
		Health & Wellness @		--	1	--			100
	Total			30	23	--	--	--	800
IV	I	Ability Enhancement Course – VII (AEC - VII)	(Tamil \$ / Other Languages +, #)	6	3	3	30	70	100
	II	Ability Enhancement Course – VIII (AEC - VIII)	English Course - IV	6	3	3	30	70	100
	III	Core Course - 4 (CC - 4)	Animal Physiology	4	4	3	30	70	100
		Core Practical - 4 (CP - 4)	Laboratory in Animal Physiology	4	4	3	40	60	100
		Allied Course – 4 (AC - 4)	Chemistry -II	4	4	3	40	60	100
		Allied Course Practical - 2 (ACP- 2)	Laboratory in Chemistry	2	4	3	30	70	100
	IV	Skill Enhancement Course - 3 (SEC - 3) ##	Naan Mudhalvan Course	2	2	3	30	70	100
		Interdisciplinary Course – 4 (IDC - 4) \$\$	One Course from Outside Department	2	2	3	30	70	100
	Total			30	26	--	--	--	800
	Summer Internship / Industrial Activity during the Summer Vacation after II Year								

V	III	Core Course - 5 (CC - 5)	Developmental Biology	4	4	3	30	70	100
		Core Course - 6 (CC - 6)	Genetics and Evolution	5	4	3	30	70	100
		Core Course - 7 (CC - 7)	Immunology	5	4	3	30	70	100
		Core Course - 8 (CC - 8)	Environmental Biology	5	4	3	30	70	100
		Core Practical - 5 (CP - 5)	Laboratory in Developmental Biology; Genetics and Evolution; Immunology; Environmental Biology	5	4	3	40	60	100
	IV	Skill Enhancement Course - 4 (SEC - 4)	1. Poultry Science (or) 2. Apiculture (or) 3. Vermiculture	2	2	3	30	70	100
		Skill Enhancement Course - 5 (SEC - 5) ##	Naan Mudhalvan Course	2	2	3	30	70	100
		Introduction to Disaster Management	-----	2	2	3	30	70	100
		Summer Internship / Industrial Activity @@	(with Viva-Voce)	--	2	--	20	80	100
		Total			30	28	--	--	--
VI	III	Core Course - 9 (CC - 9)	Microbiology	4	4	3	30	70	100
		Core Course - 10 (CC - 10)	Biotechnology	5	4	3	30	70	100
		Core Course - 11 (CC - 11)	Biochemistry and Biostatistics	5	4	3	30	70	100
		Core Project Work (CPW) @@	Project Work (with Viva-Voce)	6	4	3	20	80	100
	IV	Value Added Course	General Studies for Competitive Examinations	2	1	--	30	70	100
		Skill Enhancement Course - 6 (SEC - 6)	1. Aquaculture (or) 2. Sericulture (or) 3. Medical Laboratory Technology	2	2	3	30	70	100
		Skill Enhancement Course - 7 (SEC - 7) ##	Naan Mudhalvan Course	2	2	3	30	70	100
		Environmental Studies		2	2	3	30	70	100
		Gender Studies		2	1	3	30	70	100
		Extension Activities *		--	1	--	--	--	--
		Total			30	25	--	--	--
	Grand Total			180	150	--	--	--	4900

ALLIED COURSE

First Year

Second Year

Botany

Chemistry

SUMMARY OF CURRICULUM STRUCTURE OF UG PROGRAMMES

Sl. No.	Part	Types of the Courses	No. of Courses	Credits for each Course	Total Credits	Marks
1.	I	Ability Enhancement Course	4	3	12	400
2.	II	Ability Enhancement Course	4	3	12	400
3.	III	Core Course	11	4	44	1100
4.		Core Practical	5	4	20	500
5.		Allied Course (AC)	4	4	16	400
6.		Allied Course Practical (ACP)	2	4	8	200
7.		Core Project Work (CPW)	1	4	4	100
8.	IV	Skill Enhancement Course (SEC)	7	2	14	700
9.		Interdisciplinary Course (IDC)	4	2	8	400
10.		Value Education	1	2	2	100
11.		Health and Wellness	1	1	1	100
12.		Introduction to Disaster Management	1	2	2	100
13.		Summer Internship / Industrial Activity	1	1	1	100
14.		Value Added Course	1	2	2	100
15.		Environmental Studies	1	2	2	100
16.		Gender Studies	1	1	1	100
17.		EXTENSION ACTIVITIES (NCC / NSS / SPORTS / ANTI DRUG CELL / YRC & Any Other Activities)	--	1	1	--
Total			49	-	150	4900

SKILL ENHANCEMENT COURSE (SEC)			
Sl.No.	Title of paper	Sl.	MANDATORY Naan Mudhalvan Scheme ##
1.	Biology of Invertebrata and Chordata	1.	2nd Semester:
2.	Occupational Zoology		
3.	Laboratory Course: Biology of Invertebrata, Chordata and Occupational Zoology	2.	3rd Semester:
4.			
5.		3.	4th Semester:
6.			
7.		4.	5th Semester:
--		5.	6th Semester:

INTERDISCIPLINARY COURSE (IDC) FOR WHO HAVE OPT TAMIL AS PART – I (for other Department Students only)	
1 st Semester	Public Health and Hygiene
2 nd Semester	Economic Zoology
3 rd Semester	Food, Nutrition and Health
4 th Semester	Biodiversity and Sustainable Development

INTERDISCIPLINARY COURSE (IDC) # FOR WHO HAVE NOT OPT TAMIL AS PART - I		
Those who have studied Tamil upto 10 th +2 but opt for other languages in degree	1 st Semester	Special Tamil - I
	2 nd Semester	Special Tamil - II
Those who have not studied Tamil in school level	1 st Semester	Basic Tamil - I
	2 nd Semester	Basic Tamil – II
Those students who opt for either special Tamil (or) Basic Tamil as IDCs, have to choose 2 more IDCs courses in their 3 rd and 4 th Semester from Outside his/her department.		

INTERDISCIPLINARY COURSE (IDC) \$\$ FOR NCC CADETS ONLY	
NCC Course is a Compulsory Course for the NCC Cadets in the 3rd Semester:	NCC Course is a Compulsory Course for the NCC Cadets in the 4th Semester:
Introduction to NCC	1. Special Subject Army (or) 2. Special Subject Navy (or) 3. Special Subject Air force
Those students who opt for NCC Courses as IDCs, have to choose 2 more IDCs courses in their 1 st and 2 nd Semester from Outside his/her department.	

- \$ For those who have studied Tamil upto 10th +2 (Regular Stream)
- + Syllabus for other Languages should be on par with Tamil at degree level
- Those who have studied Tamil upto 10th +2 but opt for other languages in degree level under Part - I should
- # study special Tamil and those who have not studied Tamil in the school level should study Basic Tamil in Part – IV under the Interdisciplinary Course.
- ** Examination at the end of the next semester
- Naan Mudhalvan Scheme: As per the Naan Mudhalvan Scheme
- ## instructions, 5 courses from 2nd to 6th semester should be studied under Skill Enhancement Course.
- NCC Course is one of the Choices in the Interdisciplinary Course. Only the NCC Cadets are eligible to choose this course.
- \$\$ However, NCC Course is a Compulsory Course for the NCC Cadets.

@ **Health and Wellness: Assessments:**

- Use self-reflective worksheets to assess their understanding
- submit the worksheets to internal audit / external audit
- Every student's activity report should be documented and the same have to be assessed by the Physical Director with Mentor. The evaluation should be for 100 marks. No examination is required.

Scheme of Evaluation:

Part	Description	Marks
A	Report	40
B	Attendance	20
C	Activities (Observation During Practice)	40
Total		100

Summer Internship / Industrial Activity

Internship will be carried out during the summer vacation after the second year. Viva-Voce will be conducted by the college and Marks shall be sent to the University and the same will be included in the 5th semester Mark Statement.

@@ Summer Internship / Industrial Activity & Project Work

Scheme of Evaluation:

Description	Marks
Report	80
Viva-Voce	20
Total	100

* Extension Activities shall be outside instruction hours.

Programme outcomes (PO):

PO 1	Disciplinary Knowledge: Broad and in-depth knowledge of advanced scientific concepts, principles, and methodologies within the chosen domain. Ability to critically explain, integrate, and apply scientific knowledge to theoretical and practical problems. Opportunities to earn additional credits through specialized and interdisciplinary courses further enhance expertise and broaden disciplinary understanding.
PO 2	Critical Thinking: Field visits, academic interactions, and experiential learning activities will help students develop critical observation, interpretation, and analytical skills. Ability to evaluate and interpret scientific data, formulate hypotheses, and draw logical conclusions. Encourages independent thinking and the ability to assess scientific problems from multiple perspectives.
PO3	Analytical Reasoning: Through classroom discussions, scientific literature reviews, and interactive learning environments, students will strengthen their analytical reasoning abilities. Ability to critically evaluate scientific texts, identify gaps in existing knowledge, formulate research questions, and synthesize new ideas and concepts. Promotes evidence-based reasoning and logical interpretation of scientific information.
PO 4	Scientific Reasoning: Strong foundation in scientific methods, experimental design, and data interpretation through laboratory-based courses. Enhances practical knowledge of scientific instrumentation, calibration procedures, laboratory safety, and appropriate research techniques. Ability to conduct scientifically sound experiments and interpret results accurately.
PO 5	Self-Directed Learning: Encourages independent and self-directed learning through assignments, field reports, project work, and literature-based studies. Ability to organize, analyze, and present scientific findings in professional formats relevant to academic and industrial settings. Fosters responsibility, time management, and continuous self-improvement in learning.
PO 6	Reflective Thinking: Laboratory-intensive core courses will expose students to a broad range of research methodologies and experimental techniques. Ability to reflect on learning experiences, evaluate the effectiveness of scientific approaches, and understand the broader applications of scientific techniques within the discipline.
PO 7	Problem-Solving Skills: Ability to develop and apply scientific principles, quantitative reasoning, and mathematical concepts to solve discipline-specific problems. Ability to analyze experimental data, interpret scientific observations, and derive meaningful conclusions. Prepares students to address real-world scientific and societal challenges effectively.
PO 8	Research-Related Skills: Internships, dissertation work, and research-oriented projects provide opportunities to design, develop, and execute independent research studies. Students gain hands-on experience in research methodology, experimental techniques, data analysis, scientific writing, and ethical research practices. These

	experiences strengthen laboratory competence and prepare students for advanced research and professional careers.
PO 9	Lifelong Learning: Cultivates a mindset of continuous learning and professional adaptability. Ability to identify gaps in knowledge and skills, adapt to emerging technologies and scientific advancements, and pursue self-directed learning throughout their careers. Encourages lifelong learning that supports academic growth, employability, and professional excellence.
PO 10	Leadership Readiness: Ability to take initiative, work collaboratively, and manage academic and research responsibilities effectively. Through seminars, group projects, internships, and research activities, students develop decision-making, problem-solving, organizational, and interpersonal skills. Ability to lead scientific teams, communicate effectively in professional environments, and contribute responsibly to academic, industrial, and societal development.

First Year

**CORE COURSE 1
INVERTEBRATA
(Theory)**

SEMESTER - I

Code:

Credit: 4

Pre-requisite: Basic knowledge in biology

Course Objectives:

- To perceive the taxonomic relationship and evolution of species.
- To identify each phylum of invertebrates and discuss their key characters.
- To appraise the diversity of invertebrate species in a phylogenetic context.
- To understand how body organization solves biological problems related to physiological and environmental challenges.
- To develop an appreciation for the role of invertebrates in biological and ecological interactions and its conservation strategies.

Detailed Course Content:

Unit I PHYLUM – PROTOZOA AND PORIFERA 8 Lectures	Introduction to principles of taxonomy and outline classification of Kingdom Animalia. General characters and classification of Phylum- Protozoa and Porifera (upto class) with examples. Detailed study – Protozoa – Amoeba (<i>Amoeba proteus</i>) Porifera – Ascon Sponge (<i>Leucosolenia</i>). General Topic: 1. Parasites of Protozoa 2. Canal system in Sponges
Unit II PHYLUM - COELENTERAT A AND PLATYHELMIN THES 8 Lectures	General characters and classification of Phylum Coelenterata and Platyhelminthes (upto class) with examples. Detailed study – Coelenterata - Aurelia (<i>Aurelia aurita</i>), Platyhelminthes – Tapeworm (<i>Taenia solium</i>). General Topic: 1. Corals and corals reefs and their importance 2. Parasitic adaptations of helminth parasites
Unit III PHYLUM - ASCHELMINTH ES AND ANNELIDA 8 Lectures	General characters and classification of Phylum Aschelminthes and Annelida (upto class) with examples. Detailed study – Ascaris (<i>Ascaris lumbricoides</i>), Nereis (<i>Neanthes virens</i>). General Topic: 1. Economic importance of Aschelminthes 2. Adaptive radiation in Annelids
Unit IV PHYLUM - ARTHROPODA AND MOLLUSCA 8 Lectures	General characters and classifications of Phylum Arthropoda and Mollusca (upto class) with examples. Detailed study – Prawn (<i>Penaeus monodon</i>), Apple snail (<i>Pila globosa</i>). General Topic: 1. Mouth parts of insects 2. Economic and ecological importance of Mollusca

Unit V PHYLUM - ECHINODERMATA AND MINOR PHYLA 8 Lectures	General characters and classification of Phylum Echinodermata (upto class) with examples and minor phyla (Mesozoa, Ctenophora). Detailed study – Starfish (<i>Asterias rubens</i>). General Topic: 1. Larval forms of Echinodermata 2. Economic and ecological importance of Echinodermata
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Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand the principles of taxonomy and classification of invertebrates.	Disciplinary Knowledge/ Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Acquire knowledge on the characteristic features of invertebrates.	Disciplinary Knowledge/ Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Identify the any species at basic level of morphology.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Aware of the multiparasitism of helminthes and their dynamics in a changing world.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Understand the economic and ecological importance of Porifera, Coelenterata and Mollusca.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Ayyar. E.M. (1966). A Manual of Zoology Part I, Invertebrata, S. Viswanathan Pvt. Ltd., Chennai.

2. Giribet, G. and Edgecombe, G. D. (2020). The Invertebrate Tree of Life. Princeton University Press.
3. Calow, P. (2012). Invertebrate Biology: A Functional Approach. Springer Science & Business Media.
4. Inver Schierwater, B. and DeSalle, R. (2021). Invertebrate Zoology: A Tree of Life Approach. United States: CRC Press.
5. Sandhu, G.S. (2005). Textbook of Invertebrate Zoology. India: Campus Books International.
6. Ruppert, E.E., Fox, R.S. and Barnes, R.D. (2004). Invertebrate Zoology: A Functional Evolutionary Approach. United Kingdom: Thomson-Brooks/Cole.7
7. Barnes, R.D., Ruppert, E.E. and Fox, R.S. (2009). Invertebrate Zoology.India: Cengage Learning.
8. Pechenik, J.A. (2014). Biology of the Invertebrates. India: McGraw-Hill Education, VII edition.
9. Shuster, S.M., Moore, W. and Brusca, R.C. (2016). Invertebrates. United States: Sinauer.
10. Brusca, G.J. and Brusca, R.C. (2003). Invertebrates. Sinauer Associates,Inc., Publishers

SEMESTER - I**CORE PRACTICAL I: LABORATORY IN INVERTEBRATA**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				-	1	3	4		
Pre-requisite	Basic knowledge in Animal kingdom								

Course Objectives:

To introduce the structure, functions and behavior of specified invertebrate organisms by the observation of both living and preserved specimens.
To reinforce the student's basic laboratory skills including microscopy, virtual dissection and careful observation.
To enrich knowledge about the lower invertebrates - used as the model organisms in the scientific research.
To find the ability to recognize the major species and subspecies of invertebrates.
To emphasize the investigating methods of evolution of species as well the current state of scientific knowledge.

Detailed Course Content:**Major Dissections**

1. Earthworm – Digestive and Nervous system
2. Cockroach – Digestive and Nervous system
3. Prawn – Digestive and Nervous system

Minor Dissection

1. Earthworm – Mounting of body setae and penial setae
2. Cockroach – Mounting of mouth parts
3. Honeybee – Mounting of mouth parts
4. Pila – Mounting of radula
5. Prawn – Mounting of Appendages

Invertebrata - List of spotters

1. **Protozoa:** Amoeba, *Entamoeba histolytica*, *Plasmodium vivax*, Euglena, Paramecium - binary fission and conjugation.
2. **Porifera:** Sycon sponge, Sponge gemmules, spicules.
3. **Coelenterata:** Obelia - entire, Physalia, Hydra, Aurelia, Ephyra larva, Sea anemone, Gorgonia (Sea fan), Fungia.
4. **Platyhelminthes:** Planaria, T.S. of Planaria, Liver fluke, Miracidium larva, Redia larva, Cercaria larva, Tapeworm, Scolex of Tape worm.
5. **Aschelminthes:** Ascaris male and female, T.S. of male and female Ascaris, Filarial worm, Pinworm, Enterobius.
6. **Annelida:** Nereis, Nereis - Parapodium, Heteronereis, Earthworm, Leech, T.S. of leech, Cheatopterus, Trochophore larva.
7. **Arthropoda:** *Penaeus monodon*, Nauplius, Zoea, Mysis, Limulus, Scorpion, Peripatus, Spider, Honeybee, Silkworm and Lac insect.
8. **Mollusca:** Pila, Lamellidens, Pearl Oyster, Chiton, Dentalium, Sepia, Nautilus, Octopus and Glochidium larva.

9. **Echinodermata:** Starfish, Sea urchin, Sea cucumber, Bipinnaria larva and Auricularia larva, Doliolaria larva and Aristotle's lantern.
10. **Minor phyla:** Rotifera, Kinorhyncha, Chaetognatha.

Field Trip: Visit to Freshwater / Marine / Estuarine ecosystem – Faunal Collection.

Submission at the time of practical Examination.

1. Report on the field study and Field trips
2. Bonafide Record.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Gain first-hand knowledge to identify and group non-chordate (species of fresh and preserved) along with larval forms.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Analyze the relationship between organisms and their environment.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Recognize the diversity from Protozoa to Echinodermata using their morphological structures.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Virtually visualize and understand the anatomy and functional features of invertebrates.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Fortify the ecological and economic importance of invertebrate diversity in their habitat.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Wallis, C. J. (2013). Practical Biology: For Advanced Level, Medical and Intermediate Students. Netherlands: Elsevier Science.
2. Ayyar. E.M. (1966). A Manual of Zoology Part I, Invertebrata, S. Viswanathan Pvt. Ltd., Chennai.
3. Lal, S. S. (2015). Practical Zoology. India: Rastogi Publications.
4. King, T., Reiss, M. and Roberts, M. (2001). Practical Advanced Biology. United Kingdom: Nelson Thornes.
5. Barnes, R. D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
6. De Iuliis, G. and Pulera, D. (2006). The Dissection of Vertebrates: A Laboratory Manual. Netherlands: Elsevier Science.
7. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
8. Jain. S (2018), Advanced Practical Invertebrate Zoology. Arjun Publishing House.
9. Verma. P.S (2010). A Manual of Practical Zoology: Invertebrates. S Chand Publishers.
10. Osborn. H.L (2015), Invertebrate Dissections. Sagwan press.
11. Sandhu G.S, (2000), Advanced Practical Invertebrate Zoology. Campus Books International Publisher.
12. Cockroach dissection- www.ento.vt.edu
13. Anatomy of earthworm: The dissection works (CD); Source – www.scienclass.com; www.neosci.com

SEMESTER - I**INTERDISCIPLINARY COURSE 1: PUBLIC HEALTH AND HYGIENE**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
Pre-requisite	Basic knowledge Public health								

Course Objectives:

• To enrich general knowledge on public health and hygiene.
• To provide information on environmental pollution related hazards and their impacts.
• To impart knowledge about communicable and non-communicable diseases and its treatment strategies.
• To create awareness of various acts for the betterment of health and hygiene.
• To clarify the importance of preventive measures against various diseases.

Detailed Course Content:

Unit I Introduction to Public Hygiene	Introduction - definition - scope of public health and hygiene – nutrition and health – classification of foods – balanced diet - protein – energy - nutritional deficiency diseases – malnutrition- Kwashiorkor, Marasmus - vitamin deficiency diseases.
Unit II Environment and Health Hazards	Environmental degradation – pollution – sources - impacts of air - water - soil and noise pollution - occupation associated health hazards and treatments. Major environmental issues - global warming - ozone depletion - acid rain and climate change. Environmental and health impact assessment - significance.
Unit III Communicable Diseases	Overview - types – mode of transmission- etiological agents - preventive and control measures of measles - malaria - hepatitis - cholera - filariasis
Unit IV Non-Communicable Diseases	Definition - types - etiological agents – control and preventive measures. Genetic diseases - cancer - cardio vascular diseases - chronic respiratory disease - diabetes - epilepsy - coronary heart diseases - hypertension. Social health - related problems - smoking - alcoholism and drug addiction - counselling - rehabilitation - de-addiction centres.
Unit V Health Education	Health care legislation in India - Medical Termination of Pregnancy Act, 1971 - Maternity Benefit Act, 1961 - Transplantation of Human Organs Act (THOA), 1994 - Child Labour (Prohibition and Regulation) Act, 1986 - Environment (Protection) Act,

	1986 - Bio-medical Waste Management Rules, 2016 - Employees' State Insurance Act (ESI), 1948. WHO Programmes – Government and voluntary organizations and their health services – precautions - first aid and awareness on epidemic/ sporadic diseases.
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Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand the concept of nutrition, balanced diet and related deficiencies.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Comprehend environmental health related risks and their impacts.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Identify the source of origin of any disease and its related symptoms.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Perceive the precautionary strategies to avoid any type of disease.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Create awareness on various health education policies, Amendments and Acts and social health programmes.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Modi, R.B.J.P. (2015). Elements of Hygiene and Public Health: For the Use of Medical Students and Practitioners. India: Elsevier Science.
2. Dunn, C.L. and Pandya, D.D. (2013). Indian Hygiene and Public Health. India: Elsevier Science.
3. David, V.M. (2013). Global Handbook on Non-communicable Diseases and Health Promotion. Germany: Springer New York.
4. Berridge, V. (2017). Public Health: A Very Short Introduction. United Kingdom: OUP Oxford.
5. Landon, M. (2006). Environment, Health and Sustainable Development McGraw Hill International.
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7. Goel, S.L. (2009). Education of Communicable and Non-Communicable Diseases. Deep Publications Pvt. Ltd.
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9. Deana, L., Katie, F, and Jan Wright. (2020). Social Theory and Health Education: Forging New Insights in Research. United Kingdom: Taylor & Francis.
10. Sudhar, R.W., Vinod, B.K, and Jiwan, P.S. (2015). Public Health and Hygiene. Success Publications

SEMESTER - II
CORE COURSE 2: CHORDATA

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				4	-	-	4		
Pre-requisite	Basic knowledge in Animal Kingdom								

Course Objectives:

To enlighten the students about the diverse forms of vertebrate organisms under five major classes.
To help the students to distinguish various vertebrate species with key characters.
To understand the classification of chordate animals up to order with suitable examples.
To acquire the knowledge on adaptations of vertebrates and their evolution.
To study the detailed knowledge of protochordates like <i>Amphioxus</i> and Chordates like Shark, Frog, Calotes, Pigeon and Rabbit.

Detailed Course Content:

Unit I Chordata 8 Lectures	General characters of Chordata and its outline classification - Origin of chordates. Prochordata: General characters of Prochordata. Detailed Study on Cephalochordata <i>Amphioxus</i> (<i>Branchiostoma lanceolatum</i>). General Topic: Retrogressive metamorphosis in Ascidian.
Unit II Vertebrata 8 Lectures	Class Pisces: General characters and classification (upto order) with examples. Detailed study <i>Scoliodon sorrakowah</i> (Shark). General Topics 1. Migration of fishes 2. Parental care in fishes. Class Amphibia General characters and classification (upto order) with examples. Detailed study <i>Rana hexadactyla</i> [Frog]. General Topic: Gymnophiona and their affinities.
Unit III Class Reptilia 8 Lectures	General characters and classification (upto order) with examples. Detailed study <i>Calotes versicolor</i> [Garden lizard]. General Topics 1. Identification and general characters of poisonous and non-poisonous snakes of South India. 2. Rhynchocephalia – [<i>Sphenodon punctatus</i>] - living fossil.
Unit IV Class Aves 8 Lectures	General characters and classification (upto order) with examples. Detailed Study <i>Columba livia</i> [Pigeon]. General Topics 1. Flightless birds - distribution and adaptations 2. Migration of birds

Unit V	General characters and classification (upto order) with examples. Detailed Study <i>Oryctolagus cuniculus</i> [Rabbit].
Class Mammalia	General Topics 1. Prototheria, Metatheria and Eutheria (Salient features with examples).
8 Lectures	2. Adaptations of aquatic mammals.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand about the vertebrates up to order level with suitable examples.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Gain knowledge about the adaptation and migration of important tetrapods.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Understand about the vertebrates in the food web and its diversity.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Relate about the adaptations of flightless birds and migration of birds.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Perceive information on the evolutionary relationships of tetrapods.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Ayyar. E.M. and Anantha Krishnan T.N. (1995). Manual of Zoology Vol.II, Part I & II. (Chordata), S. Viswanathan Pvt. Ltd., Chennai.
2. Satoh, N. (2016). Chordate Origins and Evolution: The Molecular Evolutionary Road to Vertebrates. Netherlands: Elsevier Science.

3. Diogo, R., Siomava, N., Ziermann, J. M., Abdala, V. and Molnar, J. (2018). Muscles of Chordates: Development, Homologies, and Evolution. United States: CRC Press.
4. Wise, J., Roush, R. and Fowler, S. (2018). Concepts of Biology. Hong Kong: Samurai Media Limited.
5. Salazar, A. (2018). Advanced Chordate Zoology. United Kingdom: EDTECH.
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7. De Beer, G. (2018). Vertebrate Zoology - An Introduction to the Comparative Anatomy, Embryology and Evolution of Chordate Animals: Creative Media Partners, LLC.
8. Kingsley, J. S. (2015). Text Book of Vertebrate Zoology. United States: FB&C Limited.
9. Lydekker, R. (2016). Reptiles, Amphibia, Fishes and Lower Chordata. United States: FB&C Limited.
10. Kardong, K. V. (2019). Vertebrates: Comparative Anatomy, Function, Evolution. United States: McGraw-Hill Education.
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12. Pough, F. H. and Janis, C. M. (2019). Vertebrate Life. United Kingdom: Oxford University Press.

SEMESTER - II**CORE PRACTICAL 2: LABORATORY IN CHORDATA**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				-	1	3	4		
Pre-requisite	Basic knowledge in Animal Kingdom								

Course Objectives:

• To impart training on the identification the vertebrate species by observing key characters.
• To make them understand the various systems of vertebrate animals.
• To demonstrate the technique of in silico dissection of vertebrate animals.
• To highlight on studying the importance of chordate animals as spotters.
• To emphasize the role and evolution of exo- and endo-skeleton in vertebrates.

Detailed Course Content:**Virtual Dissections:**

Frog / Rat – Digestive, arterial, venous, cranial nerves and reproductive systems.

Mountings:

Placoid, Cycloid and Ctenoid scales of fishes.

Spotters:

1. **Protochordata:** Amphioxus, Balanoglossus and Ascidia.
2. **Pisces:** Shark, Echeneis, Hippocampus, Exocoetus, Catla, Rohu, Mrigal and Tilapia.
3. **Amphibia:** Frog, Hyla, Salamander, Axolotl larva, Ichthyophis and Alytes.
4. **Reptilia:** Calotes, Naja, Viper, Draco, Chamaeleon
5. **Aves:** Pigeon, Parrot, Kingfisher, Owl, Quill and all types of feathers.
6. **Mammalia:** Bat, Loris, Rabbit, Rat, Echidna.
7. **Dentition:** Rabbit, Dog and Man.
8. **Osteology:** Pigeon – Synsacrum, Rabbit – Pectoral and Pelvic girdles, Forelimb and Hind limb bones

Field Trip: Visit to Zoological Museum to study the different types of animals and birds.

Submission at the time of practical Examination.

1. Report on the field study and Field trips
2. Bonafide Record.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand the classification of vertebrates.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Identify and recognize the organisms by key characters.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Integrate the ecological adaptation of the studied species.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Relate the adaptive behaviour of vertebrates.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Virtually clarify the functional structure in tetrapods.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Ayyar. E.M. and Anantha Krishnan T.N. (1995). Manual of Zoology Vol.II, Part I & II. (Chordata), S. Viswanathan Pvt. Ltd., Chennai.
2. Morgan, J. G. and Carter, M. E. B. (2008). Investigating Biology: Laboratory Manual. United Kingdom: Pearson Benjamin Cummings.
3. Hall B. K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
4. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press
5. Lal. S. S. (2010), Practical Zoology Vertebrate, Rastogi publications, Meerut, India.
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7. Hyman, L. H. (2018). A Laboratory Manual for Comparative Vertebrate Anatomy. United States: Creative Media Partners, LLC.

8. Das. S.K, Poddar. T.K, Mukhopadhyay.S (2015), An Advanced Laboratory Manual of Zoology. Trinity Press.
9. Arumugam. N, Thangamani. A, Prasanna kumar. S, Narayanan.L.M, Jayasurya, (2013), Practical Zoology Volume 2 Chordata. Saras publications. Anatomy of Frog: Pro Dissector (CD)- www.prodissector.com
10. Physiology of Frog: Physio Ex 4.0 (CD)- www.physioex.com
11. Anatomy of shark: Shark dissection and anatomy (video)- www.neosci.com
12. Mammalian Physiology- www.biopac.com

SEMESTER - II**INTERDISCIPLINARY COURSE 2: ECONOMIC ZOOLOGY**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				2	-	-	2		
Pre-requisite	Basic knowledge in Economically Important Animals								

Course Objectives:

To introduce students to the economic importance of animals and their contributions to human society.
To provide knowledge of beneficial and harmful animals and their management
To understand animal-based industries and their applications in livelihood generation.
To promote sustainable utilization and conservation of zoological resources.
To develop practical and entrepreneurial skills in economically important animal enterprises.

Detailed Course Content:

Unit I Vermiculture	Vermiculture and composting – introduction - scope - species of earthworm –rearing technology – management – economic importance – potential use in vermicomposting.
Unit II Apiculture	Apiculture – introduction - scope - species of honey bee – types of bee hives – care and management – appliances used in apiculture - honey extraction – production and marketing of quality honey - nutritive - economic and medicinal value of honey.
Unit III Sericulture	Sericulture – introduction - scope - feeding habits of larvae – rearing of silkworm – life cycle of silkworm (Bombyx mori) – economic importance of silkworm and silk.
Unit IV Aquaculture	Aquaculture – introduction - scope – design, construction and management of a pond – freshwater cultivable fishes – fish feed – induced breeding – prawn culture – fish diseases – preventive measures.
Unit V Poultry Farming	Poultry farming – introduction - scope - types of poultry – brooding and rearing of chicks and management – poultry nutrition – diseases and their prevention – economic importance of poultry.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand the significance and economic value of Animal products.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Relate the economic impact of aquaculture and their global importance.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Knowledge on the farm management practices of various economically important species.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Management of techniques in various agro-based cultures and to make up value added products from animal husbandry.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Enrich knowledge on various basic and advanced disease prevention methods adopted in rearing practices.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Shanmugam, K. (1990). Fishery Biology and Aquaculture. Leo Publications, Madras, India.
2. Kameshwar Pandey. and Sukla J.P. (2019). Fish and fisheries. Rastogi Publications. IV Edition.
3. Babu, K.M. (2018). Silk: Processing, Properties and Applications. United Kingdom: Elsevier Science.
4. Rosser, D. (2021). Worm Farming: An Essential Guide to Vermiculture, Vermicomposting, and Making Worm Bins. Amazon Digital Services LLC - Kdp.

5. Shukla, G.S. and Upadhyay, V.B. (2016-2017). Economic Zoology. Rastogi Publications. IV Reprint, V Edition.
6. Ashok Kumar Rathoure, D.K. (2015). Applied and Economic Zoology. India: Daya Publishing House.
7. Abrol, D.P. (2013). Beekeeping: A Compressive Guide to Bees and Beekeeping. India: Scientific Publishers (India).
8. Oladottir, A.D. and Einarsson, A. (2020). Fisheries and Aquaculture – The Food Security of the Future. United Kingdom: Elsevier Science.
9. Ganga, G. and Sulochana Chetty, J. (2019). Introduction to Sericulture. Oxford & Ibh Publishing Co Pvt Ltd.
10. Ullal, S.R. and Narasimhanna, M.N. (1987). Handbook of Practical Sericulture. Bangalore: Central Silk Board, Bombay.
11. Ghosh, N. (2020). Livestock Production Management. India: Prentice Hall India Pvt., Limited.

SEMESTER - III**CORE COURSE 3: CELL AND MOLECULAR BIOLOGY**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				3	-	-	4		
Pre-requisite	Basic knowledge about structure of cell and cellular function								

Course Objectives:

• To provide the fundamental knowledge on cell types and characters.
• To make them understand the cell structure with their significance.
• To enhance knowledge on cell organelles and their role in metabolic activities.
• To understand the cell division, its genetic makeup and its regulation.
• It facilitates to signify the structure and function at molecular level in Prokaryotes and Eukaryotes.

Detailed Course Content:

Unit I MICROSCOPY AND CYTOLOGICAL TECHNIQUES 8 Lectures	Microscopy - Principles and applications of light - phase contrast - electron microscopy - SEM, TEM. Cytological techniques - sample preparation - tissue fixation - sectioning and staining. Ultrastructure and organization of virus - bacteria - plant and animal cell.
Unit II CELL ORGANELLES I 8 Lectures	Plasma membrane - ultra structure - various models proposed - chemical composition and functions of plasma membrane. Cytoplasm - structure and composition - physical and biological properties. Cytoskeleton - components - structure and functions. Endoplasmic reticulum - ultrastructure - types and functions.
Unit III CELL ORGANELLES II 8 Lectures	Golgi complex - morphological - structure - role in secretions and other functions. Lysosome and centrosome - origin - morphology - chemistry and functions. Peroxisomes and their functions. Mitochondria - Ultrastructure and functions. Ribosomes - Ultrastructure, types and functions.
Unit IV CELL ORGANELLES III AND CELL DIVISION 8 Lectures	Nucleus - ultrastructure of interphase nucleus. Nucleolus and chromosome - structure and functions. Special types of chromosomes - Giant chromosomes - Polytene and Lampbrush chromosomes. Molecular structure of DNA - RNA - types and functions. Cell division - mitosis and meiosis Cell cycle - its regulation and significance.
Unit V MOLECULAR EVENTS AND CANCER BIOLOGY 8 Lectures	Molecular events - DNA - replication in Prokaryotes and Eukaryotes - DNA damage and repair mechanisms. Protein synthesis - genetic code - transcription - translation and post-translational modifications. Aging - factors causing aging. Cancer biology - apoptosis - mechanism of programmed cell death and stem cells.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand the principles of microscopes and cytological techniques.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	Describe the structure and functions cell and cell organelles.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	Recognize the properties of cytoplasm and ultra-structure of nucleus and the metabolic machinery of the cell.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO4	Explain cell cycle and types of cell division.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	Relate on molecular events of cell and in cancer biology.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Verma, P.S. and Agarwal, V.K. (2003). Cell Biology (Cytology, Biomolecules and Molecular Biology). S. Chand Company Ltd, New Delhi.
2. Powar, C.B. (2019). Cell Biology. Himalaya Publishing House, Bombay.
3. Lodish, H., Berk, A., Kaiser, C.A. and Krieger, M. (2021). Molecular Cell Biology. IX Edition, W. H. Freeman Publisher
4. Jeon, K. (2015). International Review of Cell and Molecular Biology. Elsevier Publication.
5. Karp, G., Iwasa, J. and Marshall, W. (2019). Karp's Cell and Molecular Biology. IX Edition, Wiley Publication.
6. Kumar, H.D. (2003). Molecular Biology. Vikas Publishing House Pvt. Ltd., New Delhi.

7. Rastogi, S.C. (2008). Cell and Molecular Biology. II Edition, New Age International (P) Ltd., New Delhi.
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9. Dubey, R.C. (2008). A Text Book of Biotechnology. S. Chand & Co, New Delhi.
10. Cooper, G.M. and Hausman, R.E. (2009). The Cell – A Molecular Approach. Edition, ASM PRESS, Washington, DC.

SEMESTER - III**CORE PRACTICAL 3: LABORATORY IN CELL AND MOLECULAR BIOLOGY**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				-	1	3	4		
Pre-requisite									

Course Objectives:

• To provide practice on handling of microscope.
• To differentiate the types of dyes and stains used in histology.
• To clarify the process of cell division and its phases.
• To relate the principle and role of polytene chromosomes.
• To highlight the role of Barr body.

Detailed Course Content:**Major Experiments:**

1. Onion root tip – squash preparation and study of mitosis.
2. Grasshopper testes - squash preparation and study of meiosis.
3. Chironomous larva - squash preparation and study of giant chromosomes.
4. Enumeration of red blood cells (RBC) in human blood by using haemocytometer.
5. Enumeration of white blood cells (WBC) in human blood by using haemocytometer.
6. Preparation of buccal smear – observation of squamous epithelial cells (Barr body) in human.
7. Measurement of the size and volume of cells using ocular and stage micrometer.

Spotters:**Permanent slides:**

Sections of columnar, ciliated, squamous epithelium, cardiac, striated, non-striated muscle cells, nerve cell, blood cells of human and frog.

Models:

DNA, DNA replication and types of RNA.

Instruments:

Compound microscope, centrifuge, micrometer, camera lucida.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Familiarize on the handling of microscopes and its applications.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	Differentiate the cell cycle	Disciplinary Knowledge/ Communication

	stages in plant / animal cells.	Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	Infer the importance of giant chromosomes during the development of larval stages.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO4	Handle and perform the histological procedures and observation of stages.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	Relate the fundamental composition of blood components.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Rajan, S. and Selvi Christy, R. (2015). Experimental Procedures in Life Sciences. CBS Publications and Distributors.
2. Sisodia, R. and Majumdar, R. (2018). Laboratory Manual of Cell Biology, Prestige Publishers.
3. Poonja, S.H. and Shetty, B. (2017). Histology Practical Manual. III Edition, Jaypee Brothers Medical Publishers.
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5. Sati, B.K. and Gupta, A. (2019). Practical Laboratory Manual - Cell Biology, Lambert Academic Publishing.
6. Trigunayat, M.M, and Trigunayat, K. (2019). A Manual of Practical Zoology: Biodiversity, Cell Biology, Genetics & developmental Biology. Scientific Publishers.
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9. Karp, G. (2013). Cell and Molecular Biology, Cell Biology Lab Manual, VII Edition, United States: Wiley.

10. Carson, S., Miller, H.B., Witherow, D.S., Carson, S. (2012). Molecular Biology Techniques: A Classroom Laboratory Manual. Netherlands: Elsevier Science.
11. Gerstein, A.S. (2004). Molecular Biology Problem Solver: A Laboratory Guide. Germany: Wiley.

SEMESTER - III**INTERDISCIPLINARY COURSE 3: FOOD, NUTRITION AND HEALTH**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				2	-	-	2		
Pre-requisite	Basic knowledge in biology								

Course Objectives:

• To introduce the basic concepts of food, nutrition, and health
• To understand the nutritional value and physiological functions of various nutrient
• To study balanced diets, nutritional requirements, and nutritional disorders
• To learn principles of food safety, hygiene, and preservation
• To develop skills for healthy dietary planning and health promotion

Detailed Course Content:

Unit I NUTRITION AND DIETARY NUTRIENTS	Basic concepts of Food: Components and nutrients. Concept of balanced diet, nutrient requirements and dietary pattern for different groups viz., adults, pregnant and nursing mothers, infants, school children, adolescents and elderly people.
Unit II MACRO NUTRIENTS AND MICRONUTRIENTS:	Macronutrients. Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role. Micronutrients. Vitamins - Water-soluble and Fat-soluble vitamins - their sources and importance. Important minerals viz., Iron, Calcium, Phosphorus, Iodine, Selenium and Zinc: their biological functions.
Unit III MALNUTRITION AND NUTRIENT DEFICIENCY DISEASES	Definition and concept of health: Common nutritional deficiency diseases- Protein Malnutrition (e.g., Kwashiorkor and Marasmus), Vitamin A deficiency, Iron deficiency and Iodine deficiency disorders- their symptoms, treatment, prevention and government initiatives.
Unit IV BALANCED DIET AND NUTRITION	Balanced diet and dietary guidelines -Recommended Dietary Allowances (RDA) - Nutritional requirements during infancy, childhood, adolescence, adulthood, pregnancy, and old age - Nutritional assessment methods - Meal planning and dietary modification
Unit V DISEASES CAUSED BY MICROORGANISMS	Food hygiene: Potable water- sources and methods of purification at domestic level. Food and Water-borne infections: Bacterial diseases: cholera, typhoid fever - viral diseases: Hepatitis, Poliomyelitis - Protozoan diseases: amoebiasis, giardiasis - Parasitic diseases: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand the role of food and nutrients in health and disease	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Gain knowledge about hygiene, food safety, disease transmission.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Identify nutritional disorders and suggest preventive measures	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Design balanced diets for health promotion and disease prevention	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Understand the Relationship between nutrition and health	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Mudambi, S.R. and Rajagopal, M.V. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed;; New Age International Publishers.
2. Srilakshmi, B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
3. Swaminathan, M. (1986). Handbook of Foods and Nutrition; Fifth Ed; BAPPCO.
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5. Lakra, P. and Singh M.D. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.
6. Gibney, M.J. et al. (2004). Public Health Nutrition; Blackwell Publishing

SEMESTER - IV
CORE COURSE 4: ANIMAL PHYSIOLOGY

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				4	-	-	4		
Pre-requisite	Basic knowledge in tissue, organ, organ system and their function								

Course Objectives:

• To familiarize students with the principles and basics of animal physiology.
• To integrate the body functions, its adaptations with respect to its external and internal environment.
• To understand about nervous integration, sensation, metabolism and reproduction.
• To provide knowledge about the nutrition and balanced diet.
• To compare and signify the structure and functions of various organ systems.

Detailed Course Content:

Unit I FOOD AND NUTRITION 8 Lectures	Nutrition – composition of food- food requirements – calorific values – carbohydrates – proteins – fats – minerals and vitamins. Digestive system – enzymes and their role in digestion – absorption – assimilation. Metabolism of proteins – carbohydrates and lipids. Balanced diet – malnutrition- Basal Metabolic Rate (BMR) and Body Mass Index (BMI).
Unit II RESPIRATION AND CIRCULATION 7 Lectures	Respiration – types of respiration – structure of lungs and gaseous exchange – transport of O ₂ – transport of CO ₂ – structure and functions of haemoglobin. Circulation – structure and functions of mammalian heart Myogenic and neurogenic heart. Properties and functions of blood – heart attacks and cardiac arrest.
Unit III EXCRETION AND MUSCULAR ORGANIZATION 7 Lectures	Excretion – structure and function of kidney – nephron – mechanism of urine formation. Osmotic and ionic balance regulation in freshwater and marine animals. Muscles – structure – composition and types of muscles – Structure of skeletal muscle – mechanism of muscle contraction.
Unit IV NERVE PHYSIOLOGY AND SENSORY RECEPTORS 8 Lectures	Structure of nerve cell – types of neurons – conduction of nerve impulse. Structure of synapse – mechanism of synaptic transmission. Bioluminescence – biological clock. Sensory Receptors – types – photoreceptor – structure – physiology of vision – phonoreceptors – structure and mechanism of hearing.
Unit V ENDOCRINOLOGY 10 Lectures	Endocrine glands – structure of pituitary gland – secretions of pituitary – structure and hormones of hypothalamus – adenohypophysis – neurohypophysis – secretion and functions of pineal gland. Thyroid gland – parathyroid – thymus – adrenal and pancreas. Testis and ovary – types of hormones – male and female reproductive hormones

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand and analyze the nutritional requirements and its calorific values.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	Explain and recognize the physiological structure and functions of various organs.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	Gain anatomical knowledge in predicting the physiological changes and its consequences.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO4	Understand and relate the physiological activity of sensory organs.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	Distinguish the types and functions of endocrine glands.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 – Knowledge; K2 – Understanding; K3 – Practice; K4 – Analysis; K5 – Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Kay, D.I. (2020). Introduction to Animal Physiology. United States: CRC Press.
2. Verma, P.S. and Agarwal, V.K. (2009). Animal Physiology. S. Chand & Company Ltd., New Delhi
3. Goyal, K.A. and Sastry, K.V. (2012). Animal Physiology. Rastogi Publications, Meerut, India.
4. John E. Hall. (2016). Text book of Medical Physiology. Elsevier Health Sciences, (Jordanian Edition).
5. Yancey, P., Sherwood, L. and Klandorf, H. (2013). Animal Physiology: From Genes to Organisms. Cengage Learning, Inc.,
6. Hill, R., Cavanaugh, D. and Anderson, M. (2021). Animal Physiology. United Kingdom: Oxford University Press.

7. Aschoff, J., Daan, S. and Groos, G.A. (2012). Vertebrate Circadian Systems: Structure and physiology. Germany: Springer Berlin Heidelberg.
8. Pocock, G., Richards, C.D. and Richards, D.A. (2018). Human Physiology. United Kingdom: Oxford University Press.
9. Clark, A.J. (2015). Comparative Physiology of the Heart. United Kingdom: Cambridge University Press.
10. Moyer, C.D. and Schulte, P.M. (2007). Principles of Animal Physiology. II Edition, Pearson Benjamin – Cummings Publishing Company.

SEMESTER – IV**CORE PRACTICAL 4: LABORATORY IN ANIMAL PHYSIOLOGY**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
Pre-requisite	Fundamental of physiological mechanism								

Course Objectives:

• To emphasize on basic laboratory procedures and protocols.
• To impart hands on practice on the techniques in physiology.
• To attain knowledge of important biomolecules such as carbohydrates, proteins and lipids.
• To understand the physiological process that regulates body functions.
• To imply applications and advancements.

Detailed Course Content:**Experiments:**

1. Qualitative tests for identification of Carbohydrates, Proteins and lipids.
2. Qualitative tests for identification of Ammonia, Urea and Uric acid
3. Quantitative estimation of Carbohydrates.
4. Quantitative estimation of proteins.
5. Salivary amylase activity of human saliva in relation to temperature.
6. Salivary amylase activity of human saliva in relation to pH.
7. Estimation of oxygen consumption of a freshwater fish (Winkler's method).
8. Estimation of Haemoglobin by Sahil's Haemometer.

Instruments:

Spectrophotometer, Colorimeter, Sphygmomanometer, Haemoglobinometer, Kymography.

Model:

Structure of human Eye, Ear, Kidney, Lung.

Permanent Slides:

T.S. of Pituitary, Thyroid, Parathyroid, Pancreas Adrenal glands, Testis and Ovary.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Perform physiological and biochemical assays.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	Carry out qualitative and quantitative estimations of various biomolecules.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	Expertise in the quantification of RBC and	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/

	WBC of human blood and identify pH of any sample.	Research-related Skills/ Scientific Reasoning
CO4	Gain well versed knowledge on structural aspects of DNA, plasmid, and proteins.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	Assess and able to examine various practical techniques in physiological field.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Gottam, G.S., Mittal, P.K., Gupta, B., Jindal, S.K. and Bilochi, D.R. (2020). Practical Veterinary Physiology. Satish Serial Publishing House.
2. Harsh Vardhan Bhask. (2009). Manual of Practical Physiology and Endocrinology. Campus Books International.
3. Howard, B., Nevalainen, T. and Perretta, G. (2010). The COST Manual of Laboratory Animal Care and Use: Refinement, Reduction, and Research. Taylor and Francis.
4. Patton, Kevin T. (2018). Anatomy & Physiology Laboratory Manual and E-Labs E-Book. Elsevier Health Sciences.
5. Nagarajan, P., Ramachandra, G. and Ramesh, S. (2021). Essentials of Laboratory Animal Science: Principles and Practices. Springer Singapore.
6. Martin, Terry R., David, Shier., Jackie, Butler. and Ricki, Lewis. (2000). Laboratory Manual to Accompany Hole's Essentials of Human Anatomy and Physiology. McGraw-Hill Science/Engineering/Math. XI Edition.
7. Ashish, S., Das, S. and Singh, A. V. (2014). Laboratory Manual for Biotechnology. S. Chand publications.
8. Supriya, D., Swagat, K.D. and Thatoi, H.N. (2017), Practical Biotechnology: Principles and Protocols, I K International Publishing House.
9. Lisa, A.S., Mary, E.K. and Diana, B. (2010). Laboratory Manual for Biotechnology and Laboratory Science: The Basics. Pearson.
10. Yadav, V.K. and Yadav, N. (2007). Biochemistry and Biotechnology: A Laboratory Manual. Pointer Publishers.

SEMESTER - IV

INTERDISCIPLINARY COURSE 4:

BIODIVERSITY AND SUSTAINABLE DEVELOPMENT

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				2	-	-	2		
Pre-requisite	Basic knowledge in Biodiversity								

Course Objectives:

• To imply the heritage of biodiversity of India
• To make students aware on the threats to biodiversity.
• To give an insight knowledge on developments in conservation biology.
• To make them improve in understanding the significance of biodiversity conservation and management.
• To analyze and represent various conservation measures adopted/practiced in India.

Detailed Course Content:

Unit I INTRODUCTION TO BIODIVERSITY	Biodiversity – definition - concepts - scope and significance. Levels of biodiversity - Introduction to genetic - species - ecological system biodiversity. Values of biodiversity - mega diversity zones - biodiversity hot spots with special reference to India.
Unit II THREATS TO BIODIVERSITY	Red data book - Biodiversity laws - past and present - habitat loss by natural and human induced fragmentation. Over exploitation - invasive alien species – threats and vulnerability of species to extinctions. Mass extinction - zero extinction - extinction vortex. Problems of genetic diversity loss over time – bottleneck effect - genetic drift - inbreeding depression.
Unit III CONSERVATION METHODS	Conservation strategies - in situ - ex situ conservation. Protected area concept – sanctuary - national park - biosphere reserve - tiger reserves (with examples) – zoos – botanical gardens. Core zone and buffer zone. Germ plasm conservation – DNA libraries - tissue culture and cloning. Corridor concept - conservation reserves and sacred grooves. Role of NGOs and people participation in conservation of biodiversity.
Unit IV BIODIVERSITY CONSERVATION AND MANAGEMENT	Concept of wildlife - wildlife heritage of India - causes for wildlife depletion in Indian context - concept of threatened fauna. Introduction to International efforts - Convention on Biological Diversity (CBD), International Union for Conservation of Nature (IUCN), UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). National Biodiversity Action Plan, 2002 - Introduction to Indian Wildlife (Protection) Act, 1972 - Convention for International Trade of Endangered species.
Unit V	Distribution and conservation of sea turtles - old world monkeys

FAUNAL CONSERVATION	- Indian ungulates - project tiger and its implications - project elephant and status. Conservation of Indian rhino - breeding biology and feeding ecology of elephants. Human animal conflicts and mitigation in Indian landscape – understanding national biodiversity portal. Restoration of damaged ecosystem and endangered population.
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Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand the value and responsibility to conserve biodiversity.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Relate the current threats to biodiversity and its impacts of ecosystem.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Recall the basic concepts / steps involving in conservation practices.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Be aware of the relevant legislation and recent initiatives of biodiversity conservation.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Update knowledge on the national biodiversity portal	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Krishnamurthy, K.V. (2003). Textbook of Biodiversity. Science Publication.
2. Groom, M.J., Meffe, G.R. and Carroll, C.R. (2005). Principles of Conservation Biology. III Edition, Sinauer Associates, Inc., Sunderland, Massachusetts.
3. Rangarajan, M. (2001). India's Wildlife History. Permanent Black, New Delhi, India.
4. Arumugam, N. (2014). Animal Diversity. Vol - II – Chordata. Saras Publication, Nagercoil, Tamil Nadu.
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6. Kotpal, R.L. (2015), Modern Text Book of Zoology Vertebrates. V Edition, Rastogi Publications, Meerut.
7. Thangamani, A., Prasannakumar, S., Narayanan, L.M. and Arumugam, N. (2018). A Text Book of Chordates. Saras Publication, Nagercoil, Tamil Nadu.
8. Jordan, E.L. and Verma, P.S. (2013). Chordate Zoology. XIV Edition, S Chand Publishers, New Delhi.
9. Anderson, J. and Slater, D.L. (1981). Catalogue of Mammals Vols. I and II. Cosmo Publications, New Delhi.
10. Underkoffler, S.C. and Adams, H.R. (2021). Wildlife Biodiversity Conservation: Multidisciplinary and Forensic Approaches. I Edition, Springer.

SEMESTER - V**CORE COURSE 5: DEVELOPMENTAL BIOLOGY**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				4	-	-	4		
Pre-requisite	Basic knowledge in Development of embryo and organization								

Course Objectives:

• To provide basic idea on the processes of an embryo development.
• To signify the mechanisms of development of various animals.
• To review current developments in the field of embryology.
• To emphasize the molecular regulation of development.
• To differentiate the mechanism of vertebrate and invertebrate development.

Detailed Course Content:

Unit I BASIC CONCEPTS IN EMBRYOLOGY AND GAMETOGENESIS 8 Lectures	Scope of embryology - theories on development - Baer's law - Epigenesis theory germ plasm theory - Lyon's hypothesis - gradient theory and Spemann and Mangold theory of organizers. Gametogenesis - spermatogenesis - structure and types of sperms. Oogenesis - vitellogenesis and types of Vertebrate eggs.
Unit II FERTILIZATION AND CLEAVAGE 7 Lectures	Fertilization - types of fertilization - physico-chemical changes during fertilization - theories of fertilization - parthenogenesis in lower animals. Cleavage - patterns of cleavage - factors affecting cleavage - chemo-differentiation.
Unit III BLASTULATION AND GASTRULATION 7 Lectures	Blastulation - types of blastula - Amphioxus - Frog - Chick. Gastrulation - morphogenetic movements - Amphioxus - Frog - Chick - fate maps.
Unit IV ORGANOGENESIS AND REGENERATION 8 Lectures	Organogenesis - development of heart - eye - brain of Frog - extra-embryonic membranes in Chick. Placenta in Mammals - types and physiology. Metamorphosis in Amphibians. Regeneration - types and morphological events in regeneration.
Unit V INFERTILITY MANAGEMENT 10 Lectures	Artificial Reproductive technology (ART) - definitions - precautions and health care during human pregnancy and gestation - infertility. Artificial insemination - concept of test-tube baby - methods of birth control. Factors involved in teratogenesis - nuclear transplantation - cryopreservation.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand the basic theories of development of embryo and its stages.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	Compare the formation of gametogenesis in the various Invertebrate and Vertebrates.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	Relate the process of fertilization with the onset of cleavage and gastrulation process.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO4	Know the basics of development of organs, functions of extra embryonic membranes and physiology of placenta.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	Logically view the concept infertility, birth control and applications of cryopreservation techniques.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Berrill, N.J. (1974). Developmental Biology. New Delhi: Tata Mc Graw-Hill Publishing Company Ltd.
2. Berry, A.K. (2007). An Introduction to Embryology. New Delhi. Emkay Publications.
3. Gilbert, S.F. and Barresi, M.J.F. (2020). Developmental Biology. United States: Oxford University Press.
4. Balinsky, B.I. (1981). An Introduction to Embryology. Philadelphia: W.B. Saunders Company.

5. Subramanian, M.A. (2022). Developmental Biology. India: MJP Publishers.
6. Agarwal, V.K. and Verma, P.S. (2006). Chordate Embryology. India: S. Chand & Company.
7. Carlson, B.M. (2019). Human Embryology and Developmental Biology. Netherlands: Elsevier.
8. Dale, L. and Slack, J.M.W. (2021). Essential Developmental Biology. United Kingdom: Wiley.
9. Wolpert, L. (2011). Developmental Biology: A Very Short Introduction. United Kingdom: OUP Oxford.
10. Hodge, R. (2009). Developmental Biology: From a Cell to an Organism (Genetics and Evolution). United States: Facts on File publications.
11. Subramoniam, T. (2011). Molecular Developmental Biology. United Kingdom: Alpha Science International Ltd.
12. Slack, J.M.W. and Dale, L. (2021). Essential Developmental Biology. United Kingdom: Wiley.

SEMESTER – V
CORE COURSE 6: GENETICS AND EVOLUTION

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				5	-	-	4		
Pre-requisite	Basic knowledge in genetics of inheritance and Evolutionary process								

Course Objectives:

• To highlight Mendelian inheritance and its principles.
• To explain and relate to understand the theories related to genetics.
• To impart knowledge on the similarities and differences of genetic information transfer in Prokaryotes and Eukaryotes.
• To emphasize about the chromosomal aberrations related to mutations.
• To make them understand the concepts of the species evolution and related experiments.

Detailed Course Content:

Unit I MENDELISM 8 Lectures	Mendelism – Mendelian laws of inheritance – monohybrid and dihybrid experiments – linkage – types of linkage – coupling and repulsion – chromosomal theory of linkage. Crossing over – crossing over in Drosophila – significance of crossing over – mechanism of crossing over. Chromosome map. Chromosomal theory of sex determination – sex determination in man.
Unit II SEX-LINKED INHERITANCE 7 Lectures	Sex linked inheritance – colour blindness – haemophilia – eye colour in Drosophila. Non-disjunction – Klinefelter's syndrome – Turner's syndrome – Down's syndrome. Inborn errors of metabolism – phenylketonuria – alkaptonuria – albinism. Pedigree analysis.
Unit III MUTATION 7 Lectures	Mutation – chromosomal mutations – changes in the structure and number of chromosomes. Gene mutation – Types of gene mutations – base substitution – frame shift mutation – insertion – deletion – missense – nonsense mutation – chromosomal aberrations. Gene and gene-concept – DNA as the genetic material. Gene regulation in prokaryotes – lac operon model, tryptophan operon.
Unit IV ORIGIN OF LIFE 8 Lectures	Theories of origin of life – biochemical origin of life Oparin's concept – Urey Miller's experiment. Evidences of evolution – morphological – embryological – paleontological – biochemical evidences. Lamarckism and neo – Lamarckism. Darwinism and neo-Darwinism.
Unit V SPECIATION 10 Lectures	Speciation and isolation – mimicry and colouration – principle and application of Hardy Weinberg law. Gene pool – gene-frequency. Evolution of man and culture. Geological time scale – Indian fossils – living fossils.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Apply principles of Mendelian and non-Mendelian inheritance to solve genetic problems and interpret pedigree data.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Scientific Reasoning/ Self-directed learning
CO2	Analyze genetic phenomena such as linkage, crossing over, mutation, chromosomal aberrations, and sex determination mechanisms..	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Scientific Reasoning/ Self-directed learning
CO3	Explain the fundamental principles of classical, molecular, and population genetics, including inheritance patterns, gene structure, and gene expression.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Scientific Reasoning/ Self-directed learning
CO4	Describe the mechanisms of evolution, including natural selection, genetic drift, gene flow, mutation, and speciation	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Scientific Reasoning/ Self-directed learning
CO5	Describe evolutionary history of Vertebrates.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Scientific Reasoning/ Self-directed learning
K1 – Knowledge; K2 – Understanding; K3 – Practice; K4 – Analysis; K5 – Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Ridley, M. (2009). Evolution. United Kingdom: Wiley.
2. Zeigler, D. (2014). Evolution: Components and Mechanisms. Netherlands: Elsevier Science.

3. Stebbins, G.L. (1979). Processes of Organic Evolution. India: Prentice-Hall of India Private Limited.
4. Prakash, M. (2008). Molecular Biology of Evolution. India: Discovery Publishing House Pvt. Limited.
5. Strickberger, M.W. (2000). Strickberger's Evolution. United Kingdom: Jones and Bartlett.
6. Kirkpatrick, M. and Futuyma, D.J. (2018). Evolution. United Kingdom: Oxford University Press.
7. Darwin, C. (2008). On The Origin of Species. United States: Chartwell Books.
8. Schluter, D. and Schluter, P.Z.D.D. (2000). The Ecology of Adaptive Radiation. Equatorial Guinea: OUP Oxford.
9. Kirkpatrick, M. and Futuyma, D.J. (2018). Evolution. United Kingdom: Oxford University Press.
10. Brock, J.P. (2000). The Evolution of Adaptive Systems: The General Theory of Evolution. United Kingdom: Elsevier Science.
11. Krajewski, C., Feldhamer, G.A., Stewart, K.M., Merritt, J.F. and Rachlow, J.L. (2020). Mammalogy: Adaptation, Diversity, Ecology. United States: Johns Hopkins University Press.
12. Roberts, D.A. (2018). Evolution: The Human Story. United Kingdom: Dorling Kindersley Limited
13. Brundle, J. (2017). Genetics. United Kingdom: Book Life Publishing Limited.
14. Sturtevant, A.H. (2001). A History of Genetics. United States: Cold Spring Harbor Laboratory Press.
15. Miglani, G.S. (2007). Advanced Genetics. United Kingdom: Alpha Science International Limited.
16. Agarwal, V.K. (2009). Genetics. India: S. Chand Limited.
17. Hickey, G.I., Fletcher, H.L. and Winter, P.C. (2007). Genetics. United Kingdom: Taylor & Francis Group.
18. Dawes Hoang, R., Heston, K., Meneely, P.M. and Okeke, I.N. (2017). Genetics: Genes, Genomes, and Evolution. United Kingdom: Oxford University Press.
19. Chaudhari, K. (2013). Microbial Genetics. India: Energy and Resources Institute.
20. Snyder, L.A. (2020). Bacterial Genetics and Genomics. United Kingdom: CRC Press.
21. Trempy, J. and Trun, N. (2009). Fundamental Bacterial Genetics. Germany: Wiley.

SEMESTER - V

CORE COURSE 7: IMMUNOLOGY

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				5	-	-	4		
Pre-requisite	Basic knowledge about immune system and immune response								

Course Objectives:

• To emphasize the function of immune organs and system.
• To study the structure of antigen, antibody and its interactions.
• To perceive the knowledge about the complex interactions between donor and recipient adaptive immunity.
• To understand the action mechanism of the various immune system diseases.
• To relate various applications/techniques detecting antigen, antibody or its complex.

Detailed Course Content:

Unit I IMMUNE SYSTEM 8 Lectures	History and scope of Immunology – types of immunity (Innate and Adaptive) – natural and acquired immunity. Haematopoiesis- Organs of the immune system – primary and secondary lymphatic system. Cells of the immune system – B lymphocytes – T lymphocytes.
Unit II ANTIGEN- ANTIBODY INTERACTIONS 8 Lectures	Antigens structure – properties – functions – types. Immunoglobulins – types – structure – properties – functions – Theories of antibody formation and properties. Antigen-antibody interactions – Vaccines – types and vaccination schedule. Complement system – classical and MBL pathways and its biological consequences.
Unit III TRANSPLANTA TION IMMUNOLOGY 8 Lectures	Major Histocompatibility Complex (MHC) and its significance. Genomic organization of HLA complex – Endogenous – Exogenous pathways – HLA typing. Transplantation – types of grafts – examples for grafting- mechanism of graft rejection.
Unit IV IMMUNE SYSTEM DISORDERS 8 Lectures	Hypersensitivity reaction – types. Infectious diseases – viral (SARS-CoV) – bacterial (Tuberculosis) – fungal (Oral candidiasis) – parasitic (Dengue) infections – Primary and secondary Immuno deficiency diseases. Autoimmune diseases (systemic lupus erythematosus).
Unit V IMMUNO- TECHNIQUES AND ITS APPLICATIONS 8 Lectures	Agglutination – ABO Blood grouping and Rh typing. Immuno precipitation – Immuno electrophoresis –types. Hybridoma technology – Monoclonal and polyclonal antibodies production – Enzyme linked immunosorbent assay (ELISA) – types – Radio immune assay (RIA).

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand the difference types of natural and acquired immunity.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	Comprehend the Classification of immunoglobulins and their roles during antigenic response.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	Relate various mechanisms that regulate immune responses.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO4	Realize the adverse effects of immune system causing autoimmune disorders and therapeutic advancements.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	Perceive the applications antigen-antibody interactions by immunological techniques.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 – Knowledge; K2 – Understanding; K3 – Practice; K4 – Analysis; K5 – Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Rao, C.V. (2017). Immunology. III Edition, Narosa Publishing House, New Delhi.
2. Flajnik, M., Singh, N.J. and Holland. S.M. (2022). Paul's Fundamental Immunology. Wolters Kluwer Health.
3. Kannan, I. (2019). Immunology. MJP Publishers, Chennai.
4. Gupta S.K. (2017) Essentials of Immunology. II Edition, Arya Publications, New Delhi.
5. Delves, P.J., Martin, S.J., Burton, D.R. and Roitt. I.M. (2016). Roitt's Essential Immunology. XIII Edition, Wiley Blackwell Scientific Publication.

6. Male, D., Peebles, S. and Male, V. (2020). Immunology. IX Edition, Elsevier.
7. Punt, J., Stranford, S., Jones, P. and Owen, J.A. (2018). Kuby Immunology. VIII Edition, WH Freeman Co.
8. Shetty, N. (2021). Immunology. New Age International (P) Limited, Publishers. New Delhi.
9. Shastri, N.V. (2005). Principles of Immunology. Himalaya Publishing House, Delhi.
10. Annadurai, B. (2009). A Textbook of Immunology and Immunotechnology. S. Chand & Company Ltd., New Delhi.

SEMESTER – V

CORE COURSE 8: ENVIRONMENTAL BIOLOGY

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				5	-	-	4		
Pre-requisite	Basic knowledge about Ecosystem								

Course Objectives:

• To provide in-depth knowledge to understand our biotic and abiotic environment.
• To enrich on fundamental ideas on ecological principles.
• To make them understand by relating community interactions.
• To impart knowledge on complex bio-geochemical cycles.
• To make them aware on the environmental issues, effects and solutions.

Detailed Course Content:

Unit I INTRODUCTION OF ECOLOGY 8 Lectures	Definition – concept and scope and types of ecology - branches of ecology. Environment - Abiotic factors atmosphere (air) - hydrosphere (water), temperature and lithosphere (soil); Biotic factors - animal association - ecological interaction – neutralism – symbiosis - commensalism - mutualism - antagonism - antibiosis - parasitism – intraspecific and interspecific interactions.
Unit II ECOSYSTEM 7 Lectures	Ecosystem - trophic levels - energy flow – ecological pyramids and productivity - food chain and food web. Principles and concepts of biogeochemical cycles – carbon - nitrogen, - phosphate and sulphur. Habitat ecology - fresh water - marine water and terrestrial habitat.
Unit III COMMUNITY AND POPULATION ECOLOGY 7 Lectures	Community Ecology – types and characteristics – stratification – community interdependence – ecotone - edge effect - ecological niche – ecological succession – types and mechanism and concept of climax. Population Ecology - population size and density – natality, mortality - age structure - population growth curve - biotic potential - population dynamics emigration and immigration. Regulation of population size.
Unit IV ENVIRONMENTAL POLLUTION 8 Lectures	Introduction - types – air - water - land - noise and radiation. Environmental Impact Assessment (EIA) - Geographic information system (GIS) - global warming and biomagnification. Biological indicators and their role in environmental monitoring. Solid waste management - effects of hazardous waste - bio medical waste management.
Unit V ENERGY AND CONSERVATION 10 Lectures	Energy types - conventional sources of energy – coal - oil - natural gas - thermal power - nuclear power. Non-conventional sources of energy – solar - wind - tidal and bio energy. Terrestrial resources - forest and agriculture. Aquatic resources and their conservation. Wildlife

	conservation - sanctuaries and national parks - conservation and management, in-situ and ex-situ conservation.
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Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand the basic components on environment.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	Acquire knowledge on complex food chain/web of different ecosystems.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	Create ideology and promotes to conserve / formation of community / an ecosystem.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO4	Know about various effects of pollutions and its preventing measures.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	Gain knowledge and awareness about conservation / management of biodiversity.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

STUDY TOUR:

Study Tour to a minimum of 3 days to be conducted compulsory exposing students to different habitats like forest. ecosystem / wild life sanctuaries, zoo, Aquarium, Marine habitat Bird sanctuaries, Museums, Snake parks, Biotechnology industries, micro biology lab, Apiculture, Sericulture and Vermiculture farms and submit to Tour Report.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Jones, A.M. (2006). Environmental Biology. India: Taylor & Francis.
2. Odum, E.P. (2005). Fundamentals of Ecology. India: Cengage Learning India Private Limited.
3. Van Dyke, F. and Lamb, R.L. (2020). Conservation Biology: Foundations, Concepts, Applications. Switzerland: Springer International Publishing.
4. Khoiyangbam, R.S. (2015). Introduction to Environmental Sciences. India: Teri (The Energy and Resources Institute).
5. Schroer, J. and Ramsay, J. (2020). Environmental Biology. Kendall Hunt Publishing Company.
6. Bailer, A. (2020). Statistics for Environmental Biology and Toxicology. United States: CRC Press.
7. Verma, P.S. and Agarwal, V.K. (2000). Environmental Biology: Principles of Ecology. India: S. Chand Limited.
8. Jones, A.M. (2006). Environmental Biology. India: Taylor & Francis.
9. Strayer, D.L., Weathers, K.C. and Likens, G.E. (2012). Fundamentals of Ecosystem Science. Netherlands: Elsevier Science.
10. Thipse, S.S. (2014). Energy Conservation and Management. United Kingdom: Alpha Science International, Limited.
11. Demirel, Y. (2021). Energy: Production, Conversion, Storage, Conservation, and Coupling. Switzerland: Springer International Publishing.
12. Spellman, F.R. (2021). The Science of Environmental Pollution. United States: CRC Press.

SEMESTER - V**CORE PRACTICAL 5: LABORATORY IN DEVELOPMENTAL BIOLOGY;
GENETICS AND EVOLUTION; IMMUNOLOGY;
ENVIRONMENTAL BIOLOGY**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				-	1	3	4		
Pre-requisite	Basic knowledge in Laboratory Practices								

Course Objectives:

• To observe the developmental stages and organ formation of Vertebrate species.
• To learn methods of Mendelian genetics – testing.
• To understand pedigree construction, analysis and risk calculation.
• To understand genetic importance and evolutionary significance.
• To familiarize the various immunological assays and staining techniques.

Detailed Course Content:**DEVELOPMENTAL BIOLOGY****Experiments:**

1. Observation of the structure of live spermatozoa of Bull.
2. Observation of sperm motility of bull.

Permanent Slides:

1. **Frog** - Egg, Cleavage, Blastula and Gastrula
2. **Chick** - Egg - 24 hrs, 48hrs, 72 hrs and 96 hrs developmental stages in chick.

GENETICS**Experiments:**

1. Recording of Mendelian traits in human - tasters and non-tasters, tongue rollers, non-rollers.
2. Pedigree analysis.
3. Culture of *Drosophila melanogaster*.
4. Identification of mutants in *Drosophila*.
5. Identification of sex in *Drosophila*.

Models:

1. Monohybrid and dihybrid cross.
2. Human Karyotypes of normal male and female, Klinefelter syndrome, Turner's syndrome and Down's syndrome.

EVOLUTION

1. Animals of evolutionary importance: Peripatus, Limulus, Archaeopteryx.
2. Homologous organs: Forelimbs of Frog, Pigeon and Whale.
3. Analogous organs: Wings of Insects and Birds
4. Mimicry: Leaf insects, Stick insects, Monarch and Viceroy butterfly.

IMMUNOLOGY

1. Study of Antigen and Antibody reaction through blood grouping.
2. Study of Rh factor antigen through blood grouping.
3. Differential staining and identification of leucocytes.

Spotters:

1. Lymphoid organs - Thymus, Spleen, Bone marrow, Lymph node.

ENVIRONMENTAL BIOLOGY

1. Estimation of dissolved oxygen
2. Estimation of salinity
3. Mounting and identification of plankton (fresh water / marine)

Spotters:

Animal association, (Mutualism: Hermit crab and Sea anemone, Commensalism: Echeneis and Shark, Parasitism: Sacculina on Crab) Sandy shore, Muddy shore, Rocky shore fauna (any two).

Field Collection Methods:

Identification of common animals – Soil invertebrate diversity, diversity of birds and mammals in parks / botanical gardens / Sanctuaries and National Parks, threats to local biodiversity – Educational Tour / Field visit is compulsory.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Gain knowledge on the importance of heredity of all living organisms.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	Acquire idea about the blood types and its grouping.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	Understand the concept of Mendelian traits and pedigree concept.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO4	Realize the paleontological evidences of evolution of organisms. Gain knowledge and awareness about bio diversity conservation and management.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	Be aware on the concept of mimicry and colouration. Signify heredity importance and its dysfunctions.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Verma, P.S. (2013). A Manual of Practical Zoology of Invertebrates. New Delhi: S. Chand & Company Ltd.
2. Sam-Yellowe, T.Y. (2021). Immunology: Overview and Laboratory Manual. Switzerland: Springer International Publishing.
3. Nelson, P.N., Hay, F.C., Westwood, O.M.R. and Hudson, L. (2002). Practical Immunology. United Kingdom: Wiley Publications.
4. Mahon, C.R. and Tice, D.G. (2006). Clinical Laboratory Immunology. United Kingdom: Pearson Prentice Hall.
5. Hay, F.C. and Westwood, O.M.R. (2008). Practical Immunology. Germany: Wiley.
6. Gibbs, M.A. (2003). A Practical Guide to Developmental Biology. United Kingdom: Oxford University Press.
7. Evans, J.H., Keller, L.R. and Keller, T.C.S. (1999). Experimental Developmental Biology: A Laboratory Manual. United Kingdom: Academic Press.
8. Billett, F.S. and Wild, A.E. (2012). Practical Studies of Animal Development. Netherlands: Springer Netherlands.
9. Pendarvis, M.P. and Crawley, J.L. (2019). Exploring Biology in the Laboratory: Core Concepts. United States: Morton Publishing.
10. Koliantz, G. and Szymanski, D.B. (2009). Genetics: A Laboratory Manual. United States: Madison, WI: American Society of Agronomy: Crop Science society of America.
11. Scott, R.J. (2001). Contemporary Genetics Laboratory Manual. United States: Morton Publishing Company.
12. Gopinath, A., Perlin, M. and Beckerson, W. (2017). Cell, Genetics, and Molecular Biology: A Lab Manual. I Edition, United States: Cognella, Inc.,
13. Sullivan, W. (2004). Drosophila Protocols. China: Science Press.
14. Golic, K.G., Hawley, R.S. and Ashburner, M. (2005). Drosophila: A Laboratory Handbook. United Kingdom: Cold Spring Harbor Laboratory Press.
15. Cruz, Y.P. (2012). Laboratory Exercises in Developmental Biology. United Kingdom: Elsevier Science.

SEMESTER - V**SKILL ENHANCEMENT COURSE 4:****1. POULTRY SCIENCE**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				2	-	-	2		
Pre-requisite	Basic knowledge in Animal Husbandry								

Course Objectives:

• To introduce the principles and scope of poultry science.
• To understand poultry breeds, breeding, and reproduction
• To study poultry nutrition, feeding, and farm management.
• To develop practical and entrepreneurial skills in poultry production and marketing
• To understand processing, value addition, and quality control of poultry products

Detailed Course Content:

Unit I POULTRY PRODUCTION	Poultry production in Tropics and India, Economics of Poultry production, Egg production trends in India ; demand and supply pattern ; turkey, quail farming trends.
Unit II COMMON BREEDS OF POULTRY	Common breeds of poultry – American class, English class, Mediterranean class, Asiatic class and Indian class – Important characters of modern breeds of poultry, turkey and quail breeds.
Unit III INCUBATION AND HATCHERY MANAGEMENT	Selection and care of eggs for incubation, Hatchery hygiene and prevention of hatchery – borne diseases. Management of young birds, brooding conditions ; farm operations during brooding period. Lighting, vaccination, debeaking, coccidiosis control.
Unit IV POULTRY MANAGEMENT	Management of growers : Culling, optimal – crowding, feeding. Management of layers : Light, culling by distinction of non-layers, Litre management, Housing and equipments, floor space, feeders and waterers. Feed composition and nutrients: Grower and layer feeds
Unit V PREVENTION AND CONTROL OF DISEASES	Common bacterial, fungal, viral and protozoan diseases. Parasites : Nerrafode. Arthropod pests : Ticks, mites and their control. Marketing problems : quality of eggs, grading of eggs and meat.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	The Students will have a Knowledge about the Prospects of Poultry Industry	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	The Students will have a Knowledge about the poultry production systems, housing, automation and equipments	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	The Students will have a Knowledge about the food and feeding of poultry farming	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	The Students will have a Knowledge about the incubation and hatchery management	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	The Students will have a Knowledge about the environment, poultry production and diseases	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Bell D. Donald and Weaver D. William Jr., 2007. Commercial Chicken Meat and Egg Production. 5th Edition. Springer India Pvt. Ltd., Noida.
2. Colin G. Scanes., 2015. Sturkie's Avian Physiology. 6th Edition. Academic Press, Elsevier Inc., New York.
3. Hurd M. Louis, 2003. Modern Poultry Farming. 1st Edition. International Book Distributing Company, Lucknow
4. Leeson S., & Summers J. D., 2001. Scott's Nutrition of the Chicken. 4th Edition. University Books, Canada.

5. Mahajan Naresh, 2015. Poultry Nutrition and Management. 1st Edition. Anmol Publications Pvt. Ltd., New Delhi.
6. Mountney J. George and Parkhurst R. Carmen, 2001. Poultry Products Technology. 1st Edition. The Harwoth Press Inc., USA.
7. Ensmiger. M. E., 2015. Poultry Science. 3rd Edition. International Book Distribution Co., Lucknow, India.
8. Bell D. Donald and Weaver D. William Jr., 2007. Commercial Chicken Meat and Egg Production. 5th Edition. Springer India Pvt. Ltd., Noida.
9. Singh, R. A., 2011. Poultry Production. 3rd Edition. Kalyani Publishers, New Delhi.
10. Jadhav N. V., and Siddique M. F., 2007. Handbook of Poultry Production and Management. 2nd Edition. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.

SEMESTER - V**SKILL ENHANCEMENT COURSE 4:****2. APICULTURE**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				2	-	-	2		
Pre-requisite	Basic knowledge in Bee Keeping								

Course Objectives:

• To introduce students to the biology and behavior of honey bees
• To provide theoretical and practical knowledge of scientific beekeeping
• To understand bee diseases, pests, and their management
• To develop skills in apiary establishment and colony management
• To encourage entrepreneurship and self-employment through apiculture

Detailed Course Content:

Unit I APIARY	Apiary - Honeybee – Systematic position – Species of honey bees – Life history of Honey bee – behaviour – swarming – Pheromone.
Unit II BEE COLONY	Bee colony – Castes – natural colonies and their yield – Types of bee hives – Structure – location, care and management.
Unit III APIARY MANAGEMENT	Apiary – Care and Management – Artificial bee hives – types – construction of space frames – Selection of sites – Handling – Maintenance – Instruments employed in Apiary – Extraction instruments.
Unit IV DISEASE MANAGEMENT	Honey – Composition – uses – Bee wax and its uses – yield in national and international market – Bacterial, viral, fungal and protozoan diseases of honey bees and their control methods.
Unit V ECONOMICS OF HONEY BEE	Apiculture as Self – employment venture – Preparing proposals for financial assistance and funding agencies – Marketing of bee hives -Economics of Apiary- National Bee Board- Central Bee Research and training Institute.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Able to understand the basics of beekeeping tools, equipment, and managing beehives.	Disciplinary Reasoning/ Scientific Reasoning/ Knowledge/ Research-related Self-directed learning Analytical Skills/

CO2	Acquire knowledge to manage beehives for honey production and pollination.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Understand the primary life cycle of the honeybees, beekeeping tools and equipment	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Able to learn and manage beehives for honey production and pollination.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Understand the marketing of various bee products.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Apiculture – Sunithira. C, 2016, DivyaJothi Publication, Kanyakumari, Tamil Nadu.
2. Fundamentals of Bee keeping – Sathe. T.V., 2006, Daya Publishing House Pvt. Ltd., New Delhi.
3. Honey Bee Pests, Predators and Diseases, 3rd Edition, Roger A. Morse, b. Kim Flottum, 1998, Wicwas Press.
4. Bee Keeping in India, Ghosh. G.K., 1998, APH Publishing, New Delhi.
5. Honey – A Comprehensive Survey – International Bee Research Association for house – CNRC [England].
6. Honey Bee Biology and Bee keeping, Dewey M. Caron, 2013, Wicwas Press, Kalamazoo.
7. The Backyard Bee keeper, 3rd Edition, Kim Flottum, 2014, Quarry Books, Quayside Publishing Group, Beverly.

SEMESTER - V**SKILL ENHANCEMENT COURSE 4:****3. VERMITECHNOLOGY**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				2	-	-	2		
Pre-requisite	Basic knowledge about Earthworm								

Course Objectives:

• Acquire knowledge of the biology, ecology, life cycle, and economic importance of earthworms
• Develop practical skills in vermiculture, including the selection, culture, maintenance, and management
• Analyze common problems, pests, diseases, and management practices associated with vermiculture systems
• Promote awareness of organic farming practices and the application of eco-friendly technologies for sustainable development
• Develop entrepreneurial skills for establishing and managing small-scale

Detailed Course Content:

Unit I VERMITECHNOLOGY	Vermitechnology- Definition, scope and importance; Earthworm classification-Anecic, Endogeic, Epigeic -common species for culture; recent development in other countries and India.
Unit II VERMICOMPOSTING PROCESS	Vermicomposting process, types of vermicomposting, Monoculture and polyculture techniques, factors affecting vermicomposting- pH, temperature, moisture, humidity etc.
Unit III VERMICOMPOSTING METHODS	Vermicomposting of wastes in field pits, ground heaps, tank method, roof shed method, static pile windrows, top fed windrows, wedges and bin method, nutritional composition of vermicompost, Vermiwash-Preparation and application.
Unit IV APPLICATIONS OF VERMICOMPOSTING	Applications of vermicomposting in agriculture and Horticultural practices, Vermiculture biotechnology, earthworms for management of municipal, selected biomedical solid wastes.
Unit V	Earthworm predators, parasites and pathogens. Microorganisms associated in earthworm guts. Marketing the products of

VERMICOMPOST AND MARKETING	vermiculture, Advantages of vermicompost and marketing, packaging and transport.
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Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Learn about the characteristics and biology of earthworm.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Understand about the methods of composting.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Identify the any species at basic level of morphology.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Evaluate the role of vermitechnology in waste management, nutrient recycling, soil health improvement,	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	organic farming practices and the application of eco-friendly technologies for sustainable development	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Edwards, C.A., and Bother, B. 1996: Biology of Earthworms - Chapman Hall Publ. Co., London.
2. Ismail, S.A. 1997: Vermitechnology - the Biology of Earthworms - Orient Longman Publ. - India.
3. Ranganathan, L.S. 2006: Vermibiotechnology from soil health to Human health - Agrobios - India.

4. Talashikar, S.C. 2008: Earthworms in Agriculture - Agrobios - India
5. Gupta, P.K. 2008: Vermicomposting for sustainable agriculture [2nd edition] - Agrobios - India.
6. EIRI Board, 2015: Handbook of Biofertilizers and Vermiculture, New Delhi, India.
7. NIIR Board: The complete technology book on Biofertilizers and organic farming New Delhi, India.
8. Mary Violet Christy, A. 2008: Vermitechnology - MJP Publishers, Chennai , India. 26
9. Rajeev Prathap Singh. 2012: Organic Fertilizers: Types, Production and Environmental Impact Nova Science Inc. New York.
10. Keshav Singh, 2014: A textbook on Vermicompost, Vermiwash and Biopesticide. Biotech Books, Astral International, New Delhi, India.

SEMESTER - VI
CORE COURSE 9: MICROBIOLOGY

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
Pre-requisite	Basic knowledge about bimolecular, biological mechanism underlying micro-organism life								

Course Objectives:

• To understand and relate the general characteristic nature of microbes.
• To describe about bacterial growth and techniques involved.
• To explain by differentiating on the beneficial and harmful microbes around us.
• To signify the principle role of microbes in food spoilage and how to preserve from spoilage.
• To explicit the methods to recognize/diagnose common infectious diseases through symptoms and treatment strategies.

Detailed Course Content:

Unit I CHARACTERISTIC S OF MICROBES 8 Lectures	History and scope of microbiology - contribution of Anton Von Leeuwenhoek - Edward Jenner - Robert Hooke. Classification of microbes - five kingdom and three kingdom concepts.. General characteristics, classification and structure of bacteria, fungi and virus.
Unit II BACTERIAL GROWTH 7 Lectures	Concept of sterilization - physical and chemical methods of sterilization. Stains and staining techniques. Bacterial culture media types - synthetic complex - selective - enrichment - differential media - nutrition, growth factors and isolation of pure culture.
Unit III ENVIRONMENTAL MICROBIOLOGY 7 Lectures	Microbes in aquatic environments - microbiological analysis of water - fresh water and marine water. Overview of soil microbes - interactions with the ecosystem. Microorganisms in extreme environments - thermophiles - methanogens - halophiles. Photosynthetic bacteria. Principles and degradation of common pesticides - metals and biosurfactants. Microbes in wastewater treatment.
Unit IV FOOD MICROBIOLOGY 8 Lectures	Growth of microorganisms in food - intrinsic and extrinsic factors. Food borne infections and intoxications – microbial growth and food spoilage – Clostridium botulinum - Salmonella - Staphylococcus aureus – microtoxins in food with reference to Aspergillus species. Principles and methods of food preservation – processing, food safety - quality control and packaging.
Unit V MEDICAL MICROBIOLOGY 10 Lectures	Microbial pathogenesis - laboratory diagnosis treatment. Respiratory diseases - rheumatic fever – pneumonia. Gastrointestinal diseases – cholecystitis - typhoid. Viral diseases - Polio - herpes - hepatitis - rabies - dengue - AIDS. Fungal diseases - cutaneous mycoses – Tineapedis (Athlete's

	foot) - systemic mycoses – histoplasmosis - opportunistic mycoses - candidiasis .
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Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Apply knowledge to understand classification of microbes and its basic characteristics.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	Acquire information on methods of sterilization of microbial cultures and requirements for the media preparation.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	Attain knowledge about the interactions of microbes with their ecosystem.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO4	Perceive the role / action mechanism microbes on food spoilage and the principles of food preservation.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	Comprehend various diseases caused by the microbes and its treatments.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Willey, J.M., Sherwood, L. and Woolverton, C.J. (2014). Prescott's Microbiology. Mc-Graw Hill, New York.
2. Dubey, R.C. and Maheshwari, D.U. (2005). A Text book of Microbiology. S. Chand and Company Ltd, New Delhi.

3. Rao, A.S. (2001). Introduction to Microbiology. Prentice Hall of India Private Limited, New Delhi.
4. Pelczar, M.J., Chan, E.S. and Kreig, N.R. (1993). Microbiology. IV Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. Purohit, S.S. (2005). Microbiology Fundamentals and Applications. VI Edition (Student Edition), Agrobios (India), Jodhpur.
6. Raman Rao, P.V. (2005). Essentials of Microbiology. CBS Publishers and Distributors, New Delhi.
7. Malacinski, M.G. (2006). Essentials of Microbiology. Narosa Publishing House, New Delhi.
8. Narayanan, L.M., Selvaraj, A.M. and Arumugam, N. (1999). Microbiology. Saras Publication, Nagercoil.
9. Ananthanarayanan, R. and Jayaraman Paniker, C.K. (1990). Text Book of Microbiology. Orient Longman Ltd.,
10. Murray, P.R., Rosenthal, K.S, and Pfaller, M.A. (2016). Medical Microbiology E-Book, VIII Edition, Elsevier

SEMESTER - VI
CORE COURSE 10: BIOTECHNOLOGY

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				5	-	-	4		
Pre-requisite	Basic knowledge in genetic mechanism and molecular process								

Course Objectives:

• To enlighten on various aspects of scopes in biotechnology.
• To make aware on various applications in genetic engineering, gene cloning techniques.
• To share knowledge on various molecular markers and its potential applications.
• To enlighten the applications of biotechnology in the field of medicine and therapies for human welfare.
• To encourage students to take biotechnology as their career as it provides ample scope for bright future.

Detailed Course Content:

Unit I HISTORY AND SCOPE 8 Lectures	Biotechnology – definition - history - scope - important landmarks and applications of biotechnology. Genetic engineering and gene cloning methods - tools of genetic engineering. Gene cloning vectors - pBR322 plasmid-
Unit II GENE TRANSFER MECHANISMS AND SCREENING 8 Lectures	Gene transfer mechanisms - bacterial conjugation - transformation – transfection - transduction. Microinjection - electroporation – microprojectile. Selection, screening) of recombinants - colony hybridization.
Unit III GENETIC ENGINEERING AND ITS APPLICATIONS 8 Lectures	Genetic engineering for human welfare - production of recombinant insulin - somatotropin (HGH) - human interferons. Vaccine - types - applications. Transgenic animals - production and their uses. Animal biotechnology - requirements for animal cell culture – maintenance and storage of cell lines - Cryopreservation – methods – advantages - cell bank.
Unit IV MOLECULAR MARKERS 8 Lectures	Molecular markers - applications - Restriction Fragment Length Polymorphism (RFLP) – Random Amplified Polymorphic DNA (RAPD). PCR (Amplification of DNA) – applications of PCR Technology. DNA sequencing methods – Maxam and Gilbert method - Sanger's method and DNA finger printing and applications
Unit V ENVIRONMENTAL BIOTECHNOLOGY 8 Lectures	Microorganisms in pollution control – bioremediation of heavy metals, dyes, and paper & pulp industries – biodeterioration - biological bleaching - biomass production - bio-fuels - bio-prospecting.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Know the scope and various applications in biotechnology.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	Realize gene cloning principles in Prokaryotes and basic techniques involved in human genome project.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	Acquire knowledge on techniques and the applications of genetic engineering in diagnosis and prevention of genetic diseases.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO4	Understand applications of transgenic animals.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	Apply with gained knowledge on recombinant DNA technology in solving environmental issues.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Gahlawat, S.K. and Duhan, J.S. (2018). Advances in Animal Biotechnology and its Applications. Springer, Nature.
2. Godbey, W.T. (2014). An introduction to Biotechnology: The Science Technology and Medical Applications. Woodhead Publishing.
3. Satyanarayana, U. (2020). Biotechnology. Books and Allied (p) Ltd, Kolkata.
4. Dubey, R.C. (2014). A Text book of Biotechnology. S. Chand and Company Ltd, New Delhi.

5. Gupta, P.K. (2017). Biotechnology and Genomics. I Edition, VII Reprint), Rastogi Publications, Meerut.
6. Purohit, S.S. (2010). Biotechnology. Agrobios publishers (P) Ltd., Jodhpur.
7. Pranav Kumar and Usha Mina. (2015). Biotechnology: A Problem Approach. VI Edition, Pathfinder Publication.
8. Kumerasan, V. (2014). Biotechnology. (Revised Edition), Saras Publications, Kanyakumari.
9. Ignacimuthu, S.J. (2008). Biotechnology – An Introduction. Narosa Publishing House New Delhi.
10. Arora, P.M. 2003. Biotechnology. I Edition, Himalaya Publishing House, Mumbai.
11. Gupta, P.K. 2001. Elements of Biotechnology and Genomics. I Edition, Rastogi Publications, Meerut.
12. Das, H.K. 2005. Text book of Biotechnology. II Edition, Wiley Dreamtech India (P) Ltd., New Delhi.

SEMESTER - VI**CORE COURSE 11: BIOCHEMISTRY AND BIOSTATISTICS**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				5	1	-	4		
Pre-requisite	Basic knowledge in biomolecules, metabolic pathway and their function Basic knowledge in descriptive statistics								

Course Objectives:

To study the structure of biomolecules and their importance in the life process.
To define and explain the basic principles of biochemistry.
To get a basic knowledge of statistical methods and computations in biology.
To study the application of information technology.
To emphasize management and analysis of biological data.

Detailed Course Content:

Unit I PRINCIPLES OF BIOCHEMISTRY 8 Lectures	Introduction to biochemistry – scope and importance. Structure of atoms and molecules. Chemical bonds - Structure, composition and classification of carbohydrates, proteins and lipids. Chemistry of fat- and water-soluble vitamins.
Unit II METABOLISM 7 Lectures	Metabolism – Carbohydrates, proteins and lipids. Enzymes – characteristics – 3D structure – mechanism of enzyme action – theories – factors affecting enzyme action.
Unit III THERMODYNAMICS 7 Lectures	Thermodynamics – law of thermodynamics, role of thermodynamics in intermediary metabolism - redox reactions - redox potentials. Entropy and enthalpy. Cellular respiration.
Unit IV INTRODUCTION TO BIOSTATISTICS 8 Lectures	Definition, scope and application of statistics; Primary and secondary data: Source and implications; Classification and tabulation of biological data: Types and applications. Variables: Definition and types. Frequency distribution: Construction of frequency, distribution table for grouped data; Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram and pie chart.
Unit V MEASURES OF CENTRAL TENDENCY AND HYPOTHESIS TESTING 10 Lectures	Measures of Central tendency: Mean, Mode, Median - Uses and calculation of Mean, Standard Deviation (SD), Standard Error (SE), variance and CV. Chi-square, Student 't'-test, Tests of significance – ANOVA types - Correlation (Karl Pearsons Co-efficient) and Regression analysis .

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	To learn and understands the various properties of water.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO2	To understand the bioenergetics.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills
CO3	To know about classification, metabolism and biological significance of carbohydrate, protein and lipids.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO4	To learn properties, classification, nomenclature and action of enzymes. To learn biochemistry of antibiotics.	Disciplinary Knowledge/ Critical Thinking/ Problem Solving/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning
CO5	To learn about principles, application of instruments. To understand grouped data, identifying the relationship among the three measures of central tendency for systematical and skewed distributions, advantages and disadvantages of the three measures.	Research-related Skills/ Scientific Reasoning/ Reflective Thinking/ Self-directed learning
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Stryer, L. 1999 Biochemistry IV Edition. Freeman Company, New York

2. Lehninger, 1992 Biochemistry worth publication Inc., CBS Publication New Delhi.
3. H.S. Srivastava Elements of Bio Chemistry, Rastogi Publications.
4. Outline of Biochemistry, Corn & Stump.
5. Veerakumari.L, 2004, Bio Chemistry, MJP Publications.
6. G.P. Talwar & L.M. Srivastava, 2003 Text Book of Bio Chemistry and Human Biology Eastern
7. Economy Edition, Prentice Hall of India. New Delhi.
8. Statistics - SP Gupta 1996 S. Chand and Co., New Delhi.
9. Jerold H. Zar Bio statistical analysis [2nd Edition] Printice Hall of International edition, 1984 [Relevant portions]

SEMESTER - VI**SKILL ENHANCEMENT COURSE 6:****1. AQUACULTURE**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				4	-	-	2		
Pre-requisite	Basic knowledge in biology								

Course Objectives:

Acquire knowledge of the biology and culture requirements of economically important aquatic organisms
Understand pond construction, site selection, and water quality management
Develop skills in seed production, breeding, hatchery management, and nursery rearing
Understand disease diagnosis, prevention, and health management strategies
Promote entrepreneurship and employment opportunities

Detailed Course Content:

Unit I INTRODUCTION TO AQUACULTURE	Importance of aquaculture – over – exploitation of wild fish stocks – advantages of aquaculture – production trends in the world and in India. Scope for aquaculture in India. Basic Fish farm design : selection of site, grow – out and nursery ponds.
Unit II CULTURE METHODS	Cultivable species of fish, crustaceans, molluscs and algae. Selection of candidate species for aquaculture. Types of farming : extensive, intensive and semiintensive culture. Integrated farming. Advantages of polyculture, monosex and monoculture.
Unit III ORNAMENTAL FISH FARMING	Culture of carp species – oyster culture: pearl oyster. Prawn culture : the problems in penaeid prawn culture due to socio-economic and environmental problems. Freshwater prawn culture. Potential for ornamental fish culture. Common species for ornamental fish farming.
Unit IV FISH DISEASE MANAGEMENT	Fish disease management : Common bacterial, viral, fungal, protozoan and crustacean diseases, their symptoms and treatment. Water quality maintenance. Importance and composition of feeds ; types of feed : wet and dry feeds.
Unit V FISH MARKETING	Marketing the products : Marketing the fish to local markets and for export. Harvesting and transport. Quality control and norms of MPEDA for export of fishes. Canning and Freezing.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Apply biological and ecological principles to aquaculture production systems	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Utilize scientific methods for problem-solving in aquaculture management	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Demonstrate entrepreneurial skills for establishing and managing aquaculture ventures	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Promote sustainable and responsible aquaculture practices for environmental conservation and food security	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Assess the economic feasibility and management aspects of aquaculture enterprises	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Iso Matsui. Theory and Practice of Eel Culture. American Publishing Co. Pvt. Ltd., 1980.
2. A.B.Chaudhuri –Aquaculture ,limnology and Ichthyology Daya Publishing House ,Year :2009
3. Aquaculture –principles and practices,second edition -2005,by Blackwell publishing Ltd –T.V.R. PillaiFishing News (Books) Ltd., London, 1990. 25 Directorate of Skill Development& Entrepreneurship, Annamalai University
4. R.K. Rath-freshwater aquaculture 2nd edition, published in 2005.
5. Hutchinson, G.E. A Treatise on Limnology, Vols. I & II. John Wiley & Sons, 1957.

6. Reid, G.K. & R.D. wood. Ecology of inland waters and Estuaries. Van Nostrand Company, 1976.
7. Bardach, J.E., J.H. Ryther and W.O. McLarney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York, 868 pp.
8. Korringa, P., 1976. Farming Marine Fishes and Shrimps. Elsevier Publishing Company, Amsterdam, 208: 4.
9. Chen, T.P., 1976. Aquaculture Practices in Taiwan. Fishing News (Books) Ltd., London, 160.
10. Shigueno, K., 1993. Problems in Prawn Culture. Publisher A.A. Balkema.
11. Josianne., G Stottrup and Lesley A. McEroy, 2003. Live feeds in Marine aquaculture. Published by Wiley- Blackwell, 1st edition.
12. David, A. Bengtson, 2003. Status of Marine aquaculture in relation to live prey: past, present and future, Wiley - Blackwell.

SEMESTER - VI**SKILL ENHANCEMENT COURSE 6:****2. SERICULTURE**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				2	-	-	2		
Pre-requisite	Basic knowledge in Sericulture								

Course Objectives:

Understand the history, scope, economic importance, and prospects of sericulture
Learn techniques involved in mulberry cultivation, maintenance, and harvesting for silkworm rearing.
Develop practical skills in silkworm rearing, disease management, and environmental control
Understand cocoon production, silk reeling, processing, and quality assessment techniques
Evaluate the role of sericulture in rural development, entrepreneurship, and sustainable livelihood generation

Detailed Course Content:

Unit I INTRODUCTION TO SERICULTURE	Scope of sericulture- History of sericulture – Development of Sericulture in India – Types of mulberry and non mulberry silk industries – Economic importance.
Unit II MULBERRY CULTIVATION	Mulberry cultivation – Environmental conditions for cultivation – Temperature, humidity and light – Preparation of land. Mulberry varieties in Tamil Nadu – Methods of propagation – irrigation – manuring – application of fertilizers. Pruning – mulching – harvesting of leaves – preservation of leaves. Diseases and pests of mulberry
Unit III SILKWORM REARING	Morphology of silkworm – larva and moth. Physiology of silk gland. Life cycle of <i>Bombyx mori</i> – Rearing facilities – Rearing house – Rearing appliances – Rearing Operation. Seed production – hatching – brushing – feeling – bed cleaning – spacing – Rearing of later stages of silkworm
Unit IV SILK PRODUCTION	Mounting of silkworm for spinning cocoons – methods of mounting. Harvesting of cocoons. Quality of cocoons. Silk reeling industry and commercialization. Disease and pests of silkworm – prevention and control measures.
Unit V MARKETING	Reeling of cocoons – process of reeling – stifling and storage – storage and deflossing . Reeling equipments. Utility of by products. Mulberry plant, silkworm excreta, pupa and silk waste.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Describe the biology, life cycle, and economic importance of silkworms and host plants.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Demonstrate proficiency in mulberry cultivation and scientific silkworm rearing practices	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Identify and manage diseases, pests, and environmental factors affecting silkworm production	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Perform cocoon harvesting, silk reeling, and quality evaluation of silk products	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Evaluate the potential of sericulture as a sustainable agro-based industry and entrepreneurial venture	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Ganga G., Sulochanachetty. J. An Introduction of Sericulture. Oxford, New Delhi – 1977.
2. Johnson M., and Kesary M., Sericulture, CSI Press, Marthandam, 2008.
3. Krishnamoorthy S., Improved Method of Rearing Young Age Silk Worms: Reprinted by CSB, Bangalore, 1986.
4. Tanaka Y., Sericology, CSB, Pub., Bangalore, 1964.
5. Ullal S.R., and Narasimhan M.N., Hand Book of Practical Sericulture, CSB, Bangalore, 1987.

6. Hisao Aruga, Principles of sericulture, 1994 Oxford and IBH Publishing Company.
7. Rangaswamy.G. (1987) .Manual on sericulture FAO, Vol –IV, Agriculture service bulletin ,CSB , Bangalore , India .
8. Dandan.S.B. (2004) Hand book of new sericulture technologies ,Central Silk Board Bangalore, pp 287.

SEMESTER - VI**SKILL ENHANCEMENT COURSE 6:****3. MEDICAL LABORATORY TECHNOLOGY**

Course Code		Course Type	Core	L	T	P	C	Academic Year	2026-2027
				2	-	-	2		
Pre-requisite	Basic knowledge about Clinical Laboratory								

Course Objectives:

- To understand the different protocols and procedures to collect clinical samples. - To explain the characteristics of clinical samples. - To demonstrate skill in handling clinical equipment. - To. evaluate the safety precautions while handling clinical samples
To summaries the control measures to avoid contamination of clinical samples

Detailed Course Content:

Unit I LABORATORY SAFETY	Laboratory safety – toxic chemicals and biohazards waste - biosafety level- good laboratory practice –health and hygiene issue – physiological effect of alcohol, tobacco, smoking and junk food and its treatment
Unit II HEMATOLOGY	Composition of blood and their function - collection of blood – haemopoiesis - types of anaemia- mechanism of blood coagulation - bleeding time- clotting time - determination of hemoglobin - erythrocyte sedimentations rate - packed cell volume - Total count of RBC and WBC - Differential count WBC - blood grouping and typing – haemostasis - bleeding disorder of man - Platelet count.
Unit III MICROBIOLOGY TECHNIQUE	Definition and scope of microbiology - parasites – Entamoeba - Plasmodium- Leishmania and Trypanosome
Unit IV PHYSIOLOGY	Cardiovascular system- Blood pressure - Pulse – regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) – significance – ultra sonography- Electroencephalography (EEG).
Unit V PATHOLOGY	Handling and labelling of histology specimens - Tissue processing - processing of histological tissues for paraffin embedding, block preparation. Microtomes – types of microtome- sectioning, staining – staining methods - vital staining – mounting - problems encountered during section cutting and remedies.

Defining the Course Outcomes (NOT Unit-wise)

At the end of the course, the students will have the ability to		
CO1	Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO2	Acquire knowledge about the characteristics of clinical samples.	Disciplinary Knowledge/ Analytical Reasoning/ Research-related Skills/ Scientific Reasoning/ Self-directed learning
CO3	Demonstrate the skills in handling clinical equipment.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO4	Evaluate the hematological and histological parameters of biological samples	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
CO5	Elaborate the role of medical laboratory techniques in health care industry.	Disciplinary Knowledge/ Communication Skills/ Critical Thinking/ Analytical Reasoning/ Research-related Skills
K1 - Knowledge; K2 - Understanding; K3 - Practice; K4 – Analysis; K5 - Synthesis; K6 – Creation; K7- Evaluation		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	S	M	S	L	S
CO2	S	M	M	S	S	S	S	M	M	M
CO3	M	S	M	M	S	S	M	S	L	S
CO4	M	S	S	L	M	M	M	S	S	S
CO5	S	M	M	L	M	S	M	S	M	S
S-Strong; M-Medium; L-Low										

Recommended References:

1. Godker, P. B. and Darshan, P, Godker, 2011. Text book of medical Laboratory Technology, Mumbai.
2. Guyton and Hall, 2000. Text Book of medical Physiology, 10th edition, Elseiner, New Delhi.
3. Mukerjee, K.L, 1999. Medical Laboratory Technology- Vol,I,II,III. Tata MC GrawHill, New Delhi.
4. Sood, R, 2009. Medical Laboratory technology, Methods and interpretation.
5. Manoharan,A, and Sethuraman, 2003. Essential of Clinical Heamatology, Jeypee brothers, New Delhi.

6. Richard, A, McPherson, Mathew, R, Pincus, 2007. Clinical and management by laboratory methods, Elsevier, Philadelphia. Published by Tata McGraw-Hill Education Pvt. Ltd.,
7. Ochei. J., A. Kolhatkar (2000). Medical Laboratory science: Theory and practice, Published by Tata McGraw-Hill Education Pvt. Ltd, First edition.

PROJECT

The candidate shall be required to take up a Project Work by group or individual and submit it at the end of the final year. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the students in the beginning of the final year. A copy of the Project Report will be submitted to the University through the Head of the Department on or before the date fixed by the University.

The Project will be evaluated by an internal and an external examiner nominated by the University. The candidate concerned will have to defend his/her Project through a Viva-voce.

ASSESSMENT/EVALUATION/VIVA VOCE:**1. PROJECT REPORT EVALUATION (Both Internal & External)**

I. Plan of the Project - 20 marks

II. Execution of the Plan/collection of Data / Organisation of Materials / Hypothesis, Testing etc and presentation of the report. - 45 marks

III. Individual initiative - 15 marks

2. Viva-Voce / Internal & External - 20 marks

TOTAL - 100 marks

PASSING MINIMUM:

Project	Viva-Voce 20 Marks 40% out of 20 Marks (i.e. 8 Marks)	Dissertation 80 Marks 40% out of 80 marks (i.e. 32 marks)
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A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-voce within a month. A maximum of 2 chances will be given to the candidate.
